Short Notes on Veterinary Anatomy

—BY—

J. HUGO REED,

Professor Veterinary Science.

CANADA

PUBLIC ARCHIVES

ARCHIVES PUBLIQUES

SHORT NOTES

ON

VETERINARY ANATOMY

FOR THE

USE OF STUDENTS

AT THE O. A. C.

BY

J. HUGO REED,

Prof. Veterinary Science.

GUELPH:

O. E. TURNBULL,
PRINTER AND BINDER,
1900.

SHORT NOTES ON

VETERINARY ANATOMY.

Veterinary means belonging to beasts of burden.

Anatomy is the science of organization. Animal Anatomy or Zootomy, has for its object the investigation of the animal frame, an investigation conducted by mechanically dividing it into its compotent parts and studying their form, structure, attachments and relations.

Anatomy may be comparative, special, or transcendental, according to the scope and ultimate object in view. Thus, if more than one species of animal be under consideration, the comparative anatomist takes note of the various deviations and similarities; but if the investigations be confined to one species of animal, as in human anatomy, the subject then becomes special. When special anatomy leads to the thorough investigation of one single variety, for the purpose of comparing other classes with it, the subject of such special study is called a type.

Comparative anatomy, therefore, is not studied by the indiscriminate comparison of one type with another, but by referring them to certain types or standard. The horse is taken as the type by the Veterinary Anatomist, embracing as it does the structural investigation of the whole animal kingdom. Comparative anatomy is closely related to the science of Zoology, the latter science aiming specially at the attainment of a scientific method of classification.

Transcendental, or Philosophical Anatomy, seeks for analogies and developmental facts, which may guide the investigator in his search after primary anatomical types. Since the prosecution of such a study must assume a more or less profound knowledge of Comparative Anatomy we merely mention it in passing.

If we consider a portion of the animal body with respect to its form, size, relative position or structure, we are said to consider it anatomically; but should we enquire into the use or function of such a part, or seek to learn the changes undergone in it while in a living condition, then we are investigating physiologically. This is a general distinction between anatomy and physiology, but it will readily be seen that they are to a great extent bound up in one another, since both the sciences must lend their aid to afford a complete description of any given organ or part. The branch treating solely of structure and form is called Morphology. Histology, or minute anatomy, treats of the intimate structure of the tissues or materials of which the various parts of the body are composed. As the tissues present various characteristics invisible to the naked eye the histologist uses the microscope largely in his investigations.

Embryology, from an anatomical point of view, is a science considering the various appearances presented by an animal after each of the many successive stages of development, from when it first appears as a mere speck of vitality until it has acquired the general characteristics of a perfect animal.

Anatomy in all the above mentioned branches deals only with normal or healthy material; but should such material be in a diseased condition, the consideration of the changes it has undergone is termed Morbid Anatomy. Surgical Anatomy embraces the description and investigation of such parts of the body as are most liable to be involved in surgical operations.

Anatomy may be descriptive or practical. In the former the student relies on books, diagrams, lectures, etc., for his information; in the latter he verifies description by actual dissection and demonstration of the various structures in question. Veterinary Anatomy, in the full sense of the word, includes the anatomy of all domesticated animals, and is therefore a branch of Comparative anatomy, and the animal referred to as its type is the horse, the anatomy of which (or Hippotomy) we will consider, while the deviations from this type in other animals we will notice as fully as the scope of our work will permit.

Anatomy is a very important branch of study. It is part of the foundation upon which a knowledge of disease must be based, for if we do not understand the normal or healthy structure of a part we cannot appreciate the changes which take place in disease. To some, anatomy appears a dry subject, but apart from the practical object we have in view, much interest may be excited by the beauties of nature's designs as they become unravelled step by step. In this course we cannot give much more than an outline, but will endeavor to give enough to enable you to understand the nature of the diseases and injuries that we study.

In addition we consider that the knowledge of anatomy the student will attain here will enable him to study the points, characteristics and conformation of animals with greater ease and more thoroughly.

The animal kingdom is divided into the sub-kingdoms Invertebrata and Vertebrata. As the names imply, the latter is distinguished from the former by its members possessing a vertebral column or back bone, which forms, as it were, the axis of a bony framework, supports the head, and is placed dorsally, or in the region of the back, extending from one end of the body to the other. It is pierced throughout the greater portion of its length by a canal called the neural canal, which is continuous with a cavity in the head called the cranium. These cavities are occupied by centres from which radiate a large series of nerves termed the cerebro-spinal system. Underneath the backbone there is a second series of nerve centres, called the sympathetic system. Thus, in a vertebrate animal there are two systems of nerves whose centres are separated by a partition of bone. The remaining portion of the animal body may be regarded as a second cavity, or canal, which contains, in addition to the sympathetic system of nerves, the alimentary and the hæmal systems. The former runs the whole length of the body, being a canal which gives passage to the food, the latter consists of a series of tubes by which the blood passes through the body, both systems being supplied with many accessory organs.

In the higher invertebrate animal we find no back bone, no neural canal, and no cerebro-spinal system of nerves, but the visceral canal exists and its contents

correspond mostly with the structures found in the vertebrate.

If we eliminate from the vertebrata all the classes but the two highest—the mammalia and aves—we shall further localize our subject, since the two classes contain all the animals which, as a rule engage the attention of the veterinary anatomist, to whom the first of the two is of by far the greater importance. It is sufficient to state that mammalia are characterized by the females being provided with an apparatus which supplies milk for the nourishment of their young after birth. Aves (or birds) are distinguished from mammals by their producing their young oviparously, or by hatching the egg outside the body. They never suckle their young, and have a covering of feathers.

Descriptive Anatomy.

Osteology is the term applied to that section which treats of bones.

Arthrology, a consideration of the joints.

Myology, the muscles.

Splanchnology, the viscera.

Angiology, the circulatory and absorbent system.

Neurology, the nervous system.

Æsthesiology, the organs of sense.

Embryology, of the animal before birth.

The terms *analogy* and *homology* are frequently used, and the following distinctions between the terms may be noted: Organs are said to be analogous when, though differing in structure, they perform the same function, but when their functions are different, while in the broad sense they correspond in structure or form they are said to be homologous. Thus, the middle finger of the human hand is the homologue of the anterior digit of the horse, because they have the same general struction and relation to the rest of the limb; but as the functions they perform are quite different, they cannot be termed analogous. And then the lungs of a mammal are analogous to the gills of a fish, for though they differ widely in structure, position and form, and are therefore not homologous, their ultimate use is the same, each of them being an apparatus in which is carried on the process of purifying the blood.

Osteology.

Structure of Bones. Bones are hard, yellowish white bodies which form the internal skeleton, give attachment to soft structures and are of various sizes, forms and densities. In the limbs the bones are generally more or less cylindrical, with expanded extremities, they support the body, afford leverage and attachment to the muscles and form the basis to all joints. Where cavities such as the cranium, chest and pelvis, enclose viscera requiring protection and support, the bones assume a flat, expanded form. Living bone is bluish white, insensitive and elastic; exposed to the air it becomes diseased, assumes a black or livid hue and is extremely sensitive and painful. The teeth excepted it is harder and of a higher specific gravity than any other animal tissue. It consists of inorganic salts deposited in a basis of animal matter. It owes its density and hardness to the former, its elasticity and tenacity to the latter, the union rendering the tissue solid and elastic. By steeping bone in dilute hydrochloric, or other strong mineral acid, the earthy matter is dissolved, while the tough flexible animal cast is left. If we expose bone to the action of heat we get rid of the animal matter, while a white, brittle, earthy, chalky substance is left, retaining its original shape.

The relative proportions of animal and earthy matter vary at different periods of life. As an animal grows old the animal matter decreases, hence the bones of very old animals are brittle and easily fractured. The animal and earthy proportions do not vary in true bone tissues, but there is a gradual filling up of the cavities originally occupied by fat cells, thus condensing the bone. The earthy ingredients consist chiefly of carbonate and phosphate of lime, the animal matter of cartilage and connective tissue, vessels, lining membranes and a quantity of fat.

The following is the average analysis of the femur of a six year old horse:

Phosphate of lime (with traces of Fluoride Calcium)	54.37
Carbonate of lime	12.00
Phosphate of magnesia	1.83
Soluable salts	.70
Cartilage	27.99
Fat, etc	3.11
	100.00

The bones of young animals may have too great a proportion of animal matter, when they give way under the weight, as in rachitis. The degree of hardness varies not only with age but also with the class of animal; the bones of birds being white, hard and brittle, especially those of the wings and legs, whereas fish bones are soft and flexible. They also vary in different parts of the same skeleton, the petrosal bone being the hardest one in the body while the ribs are soft and flexible.

The leg bones of a thoroughbred horse are more compact than those of a heavy cart horse. The latter are larger but do not weigh as much in proportion, because the shell or outer layer is more expanded and thinner, affording greater surface for muscular attachment; whereas in the thoroughbred a greater density of bone is necessary to withstand the immense concussion of speedy action, therefore the bones are increased in thickness of shell, affording greater strength without apparent increase of size.

Osseous Tissue.

In bone there are two modifications of texture, the compact and the cancellated. The former, hard, dense and ivory-like, is always situated externally; the latter, porous and spongy, lies within. Compact tissue appears uniformly dense, but if we cut a bone transversely and examine with a microscope it is found to contain numerous small openings called Haversian canals for the transmission of blood vessels, which run in a longitudinal or slightly oblique direction, opening on either the outer or inner surface of the bone. They also have many transverse branches of communication which are often of greater diameter than the trunks. These canals are from 1-200 to 1-1000 of an inch in diameter and surrounded by concentric layers or lamella of bone. Among them can be seen small dark bodies (lacunæ) filled with fluid from which pass radiating lines (canalicula) which establish communication between the Haversian canals and the lacunæ. On the external part of the shell of the compact tissue of long bones are several concentric osseous layers (the peripheral lamella) passing completely around the shaft. There

is also a corresponding concentric disposition of layers on the inner or medullary surface. Both these systems of lamella are in a great measure destitute of Haversian canals, and are supplied with nutritive material by means of lacunæ and canalicula as in the compact tissue generally. Each Haversian canal may be considered a vascular longitudinal centre, round which successive concentric layers of bone are arranged so as to form a dense cylindrical ossicle. Series of these are repeated, and united by lamella destitute of canals, but with numerous canalicula and lacunæ and called the connecting or interstitial lamella, the entire structure being encircled by the external peripheral lamella. Cancellated or spongy tissue is always situated internally. It consists of a large number of fragile bony plates with spaces between them called the cancelli There are lacunæ and canalicula, but no Haversian canals, their place being taken by the cancelli. (In the bones of the cranium this tissue is called the diplœ.)

Covering of Bone.

The external surface of every bone is covered by a tough, fibro-vascular membrane, the periosteum, excepting where tendons play over the bone, and its articular surfaces, upon which there is a layer of cartilage. The periosteum, firmly adhering to the bone, contains minute blood vessels which are thickly distributed before entering the osseous tissue, and it contains two layers, an outer one, fibrous and protective, and an inner one, which consists of fine connective tissue and contains bone-producing cells. The inner layer is continued into the Haversian canals, a layer of cells also existing between the canal wall and the contained vessel. It affords support and protection to the bone and attachment to tendons and ligaments which frequently become continuous with it. It varies in thickness, being dense and strong on bones nearest the skin and liable to injury. In the young animal it is thicker and more vascular than in the adult. Blood vessels which ramify in the periosteum pass directly to the bone. The external surface of a bone is always studded with numerous foramina through which these enter. The perios-

teum, owing to its inelasticity, is, when inflamed, the seat of intense pain; and should any part of it be stripped off, there is every probability of the denuded bone dying and exfoliating. It is most vascular near the joints where it terminates by joining the articular cartilage, or passes to the next bone, but it never covers an articular surface. The internal, or madullary cavities, are lined by a more delicate vascular membrane, the endosteum or madullary membrane, which is prolonged into the cancelli and Haversian canals. It is very thin, consisting of delicate areolar tissue, fillament from which serve to support the marrow, the nutrient or madullary arteries entering the bone by the so-called nutrient foramina being chiefly distributed in it. The periosteum covering the bones of the cranial vault is called the pericranium.

Contents of Bone.

Marrow is a soft yellow fat, the cells of which are supported by areolar tissue, it is contained in the madullary canal and cancelli and thus fills up the cavaties of the bone, containing many blood vessels. The large bones of most birds in adult life contain air instead of marrow, but in the bones of a mammal in perfect health there is a considerable quantity of the latter which becomes diminished in disease. In the bones of the fœtus there is little or no true fatty matter, but a transparent redish fluid, the red marrow is found, it consists of specific myeloid cells containing numerous nuclei.

Blood vessels are numerous in bone tissue, the arteries ramifying in the periosteum enter by the Haversian canals, the madullary artery enters by the nutrient foramen, and the arteries of the cancellated tissue pass through foramina situated near the articular surfaces. The veins are numerous and do not accompany the arteries, but occupy separate canals, the diploe in the cranial bones contain large dilated veins. Lymphatics and nerves also exist in bone and its coverings.

Classes of Bone.

Bones are classed as long, flat and irregular. Long or cylindrical bones are found in the extremities, where

they serve as levers and pillars of support. For description a long bone is divided into a centre or shaft and extremities. The shaft is cylindrical and consists of a shell of compact tissue of varying thicknesses, which encloses the cancellated tissue and madullary canals, and is pierced by the madullary or nutrient foramen. It is smallest in the centre, expanding towards the extremities and is circular, oval or prismoid in form. When a long bone is placed nearly vertically under the body, the internal wall of the shaft is usually the thickest, when obliquely placed the thick portions of the shaft correspond with the line through which the centre of gravity passes. Long bones are never straight, they may be twisted, as is the humerus, and if bent are generally convex on their exposed surfaces, the shell being thickest on the concave side. The extremities of long bones always exceed the shaft in circumference and are remarkable for their irregularity of outline, they are expanded and roughened to afford surface for the attachment of tendons and ligaments, their protuberances also materially increasing the mechanical power of muscles by serving as pulleys over which the tendons play. The extremities are composed of cancellated, with a thin layer of compact tissue, the cancellated getting gradually less dense towards the centre of the shaft which is occupied by the madullary canal. While the extremities exceed the shaft in diameter their weight is not relatively greater, their increase in size being due to a diffusion and expansion of material, not to an addition of substance. This arrangement lightens and strengthens the bone besides filling its cavities with a fatty buffer to resist concussion. The hardest part of a bone is usually the thin portion lying next to the articular surface, it is only found when the bone is fully developed and it rests upon a series of arches formed by the cancelli; this thin layer is covered by cartilage. Excepting on their articulating surfaces, the extremities of long bones are copiously pierced by foramina, which chiefly transmit blood-vessels to and from the interior.

Flat or tubular bones exist where mechanical action is at a minimum and help to enclose cavities containing important organs. Thus the cranium protects the brain,

the scapula and ribs protect the respiratory organs and the heart. Flat bones are composed of two thin expanded plates of compact tissue, rarely quite parallel to each other and enclosing a cancellated structure between them. The internal is considerably harder than the external plate, but not so thick and tough, the outer being more elastic and less liable to fracture. The connecting cancellated tissue is plentifully supplied with blood vessels. In the bones of the cranium the compact plates are called the tables and the spongy tissue between, the diploe; the tables also in some facial bones may be widely separated with air cavities between them.

Irregular bones include all that are not classed with the foregoing. They are found in the vertebral column in the skull and also in the limbs. They usually possess many angles and indentations with surfaces for articulation and tendinous attachment and consist of a fine, dense, external case of compact bone, enclosing cancellated tissue. In proportion to their size they present a much larger extent of articular surface and greater mechanical strength than any other class.

Surfaces of Bone.

No bone is strictly geometrical in form, although to a casual observer some may appear so. The chief irregularities consist of certain eminences and depressions, a knowledge of which is one of the chief requisites in the study of osteology. These are either articular or non-articular; the former being clothed with cartilage and assist in forming joints. Non-articular eminences are found on t' xternal surfaces of most bones and receive the att ' ent of tendons and ligaments and they are frequently named from their real or supposed resemblance to some object. The term process may be generally applied to prominent elevations which are not necessarily non-articular. A spine is an elevation which tends to become pointed; a tubercle is a small, blunt elevation, which if more developed would be called a tuberosity, while the name trochanter is applied to the largest and most prominent of these. A crest, or ridge, implies a roughened line or border. Non-articular depresssons passing completely or partly

through a bone are called foramen, canal, aqueduct or meatus, the first name being the most used. Blind cavities on the surface of a bone are called fossa. The terms notch and fissure indicate depressions or grooves which transmit various structures. When a depression leads to two or more foramina it is called an hiatus.

Articular Eminences. A caput, or head, is a more or less semi-spherical project on supported by a roughened and constricted cervix or neck. An ovoid convexity is called a condyle, Condyles are often found in pairs, the articular surfaces of which may be continuous or separated. A trochlea is an articular surface presenting a pully-like appearance.

Articular Depressions. A glenoid cavity is shallow, and may be cup-like. When a cavity is deeper it is called cotyloid. The term facet is applied to articular surfaces large or small which are not well marked as either elevations or depressions.

Development of Bone.

Although the bones of the foal, calf, and young of other large quadrupeds posses greater solidity at birth than those of the human infant, yet they all pass through certain progressive stages of development before arriving at the degree of density which they ultimately possess. The tracing of future bone is recognized about the seventh week of fœtal development in local collections of soft granular gelatinous pulp which becomes gradually flooded with nucleated cells, held together by an opaque intercellular basis, or matrix, which with the cells equally distributed through it forms temporary cartilage, a material closely resembling ordinary gristle.

Bone is developed from temporary cartilage. The process of ossification begins at certain fixed points called ossific centre, and gradually spreads. In long bones there are three ossific centres, one in the centre of the shaft called the diaphysis and one at each extremity called the epiphysis. When any large process is superadded it possesses a distinct ossific centre called an apophysis. As ossification commences in the shaft, there are for some time after birth, intervening portions

of unossified cartilage, marked by the deep ring in the long bones of young animals; they disappear at variable periods, the portions of bone hitherto imperfectly united becoming consolidated into one firm mass. The bone increases in length by the growth of the unossified ring, uniting the shaft and epiphysis, until the ring fills up, when growth is completed. Should an epiphysis unite with a diaphysis prematurely by acceleration of the process of ossification through disease, growth being thus arrested, the bone will be shorter than its fellow. The shaft of a long bone increases in circumference by deposits of new bone on its external surface derived from the inner layer of the periosteum (which has been termed the osteogenic membrane). In the periosteum there are two layers, an outer, strong and fibrous, and an inner, soft and containing osteoplastic cells which produce layers of new bone. In flat bones ossification usually radiates from a centre and is directed by the membrane investing each surface of the bone; some of them possess numerous apophysis.

Ossification is completed in some bones much earlier than in others and at birth those which are required for support and progression are farthest advanced.

The bones of the cranial vault are developed from membrane (not from cartilage). In early fœtal life the brain is covered by two membranes closely united, viz. the pericranium and dura-mater; between these, bones become developed from radiating ossific centres. This may be termed intramembranous as opposed to intracartilaginous ossification.

The Skeleton.

By the term skeleton is generally understood the bones of an animal held in their proper positions by legiments or by wires or screws. The former is called a natural, and the latter an artificial skeleton. The majority of bones exist in pairs, but there are exceptions, as the vertebra, sternum and some of the bones of the head. Anatomists differ as to the number of bones in the skeleton, but for all practical purposes it answers to number them as 216, or including teeth 256.

In speaking of the anatomical position and relation of bones as to other structures, continual reference is

made to imaginary lines or planes. With reference to quadrupeds imaginary planes are supposed to lie as follows:

A longitudinal median vertical plane descends through the centre of the head, vertebral chain and trunk, midway between the right and left extremities to the ground, dividing the body into two exact halves. Right and left vertical planes are placed parallel to the former, but external to the body. At right angles to these an anterior vertical plane is placed in front and a posterior one behind. A superior horizontal plane lies above the body between the anterior and posterior planes, while parallel with the superior is an inferior horizontal plane placed under the feet. The external surface of an organ or region is that which faces the laternal plane on the side where the organ is situated; the internal surface faces the median plane; the anterior surface the anterior plane and the posterior surface the posterior plane. The superior and inferior surfaces are those facing their respective planes. This imaginary index may be applied to any particular region or part as well as to the whole body. Modifications of these terms are used when it is required to point out the precise situation of a structure. For example, take the anterior limb and suppose it encompassed by the planes as described. If we wish to describe the situation of any object on the upper part of the laternal region, the term supero lateral would be used If the object were on the lower lateral part, then we would say the infero lateral, or to be more explicit we would say infero external or infero internal according to whether the object be on the external or internal part of the inferior region. Similar modifications are used in speaking of the anterior and posterior surfaces. Supero anterior means the superior part of the anterior region, antero superior and anterior part of the superior region. For description, structures (especially bones) are divided into two or more parts. Thus we allude to the superior, middle and inferior third of a part. The end of a structure which is nearest to the vertebral column is often termed the proximal end, while the end furthest from the column is called the distal end. For the purpose of description the skeleton is usually

divided into head, trunk and extremities. The trunk consists of the vertebral column, ribs and sternum.

Vertebral Column.—(Lt. Verto to turn.)

The vertebral, or spinal column may be considered the foundation of the skeleton from which all other parts proceed. It extends the whole length of the body and consists of a series of single bones termed vertebræ and is divided into five regions, viz., the cervical 7, dorsal 18, lumbar 6, sacral 5, and coccygeal 13 to 20, respectively the regions of the neck, back, lions, croup and tail. While all possess certain points of confirmation in common, special peculiarities distinguish the vertebræ of any one region from that of another. Vertebræ are either true or false. True vertebræ possess certain typical parts and they never, in health, unite by ossification, while false vertebræ either do not possess the essential characters of true, or they may so unite.

True Vertebrae.

A true vertebra consists of a body, arch, notches; spinous, transverse and articular processes. The body is the solid block of bone on which all the other parts are built and it is situated below the spinal canal, its anterior surface is convex and its posterior concave. The upper surface is flat or slightly concave, its inferior surface convex and sometimes terminating in a spinous process. The arch rises for the supero-lateral surfaces of the body by two processes of bone termed pedicles, from each of which a plate of bone, the lamina, expands and passes inwards, their union in the median line completing the arch which encloses the neural canal or spinal foramen.

The notches are four in number, two anterior and two posterior, so placed that those of the anterior surface of one vertebra correspond with those of the posterior surface of another, thus forming a large opening, the intervertebral foramen, which gives passage to the spinal nerves and blood vessels.

Each true vertebra except the first two cervical ones has four oblique or articular processes (zygapophysis) on the superior and lateral parts of the arch. The faces of the anterior of these processes are directed upwards

and inwards; those of the posterior downwards and outwards. They articulate and form joints with processes of contiguous vertebræ.

The transverse processes (diapophysis) on each side spring from the sides of the body and pedicle and vary in size and shape in different regions. The spinous processes are superior and inferior; the superior being larger and of different size in different regions; the inferior are rudimentary except in the cervical region.

The bodies of the vertebræ placed in natural apposition thus form a central bony column, to which the arches and processes are attached. The arches, with their connecting ligaments, form superiorly a cavity, the spinal or neural canal, which extends from the head to the tail and contains the spinal cord with its membranes and blood vessels. The articular processes strengthen the connections, while the spinous and transverse processes are levers to which muscles are attached, their development having great influence on the physical conformation and capabilities of the animal. The ribs may be considered as continuations of the dorsal transverse processes. They form the inferior or hæmal arch of their own region.

False Vertebrae.

The false vertebræ are found in the sacrum, which consists of vertebral segments united by the ossification of their connecting material; and in the coccyx, the skeleton of which consists of rudimentary or imperfectly developed vertebræ. The sacral segments in the early stages of life are separable and present all the characteristics of true vertebræ.

Cervical Vertebrae.

General Features. There are seven cervical vertebræ in nearly all mammalia. They are numbered in order from the head; the first is called the atlas and the second the axis or vertebræ dentata; these, with the 6th and 7th differ from the rest, which are essentially alike.

The bodies of the cervical vertebræ are larger and longer than those of any other true vertebræ, are quadrangular in shape. The anterior surface or head is con-

vex and somewhat heart shaped with the apex downwards, while the posterior surface presents a corresponding cavity. The superior surface is flattened, and presents, close to the pedicle on each side a distinct furrow which contains the spinal vein; these lateral furrows are united by a transverse furrow and partly covered by a thin, bony plate. The inferior surface possess a spinous process which increases in size from before backwards, terminating in a tuberosity. The lateral surfaces of the body above the inferior spine are flattened and somewhat excavated. The superior spinous processes or neural spines are mostly rudimentary and are bifid posteriorly. The transverse processes are broad, short, strong and irregular in shape, pass directly outwards and divide into two parts. All of them except the 7th are pierced by the vertebral foramen for the passage of the vertebral artery and vein. The articular processes, larger than in any other region, have flattened, oval, articular surfaces, the anterior two looking upwards and inwards, the posterior downwards and outwards.

The 1st, 2nd, 6th and 7th having peculiar confirmation require special notice.

The Atlas (as the first is called) because in human anatomy it supports the head; in quadrupeds the head is supported from it, presents no well defined body, but consists of a strong ridge of bone, the superior surface convex with a slight longitudinal elevation in the median line from which the wings slope downwards and backwards. The wings are large, flat transverse processes wider than those of any other true vertebra, each is pierced superiorly by three foramina, two anteriorly and one posteriorly. The anterior surface presents two notches and two large concave articular facets for articulation with the condyles of the occipital bone. The posterior surface is excavated on its inferior margin to receive the odon oid process of the axis, and on each side is a broad, slightly convex articular surface. The atlas is the only vertebra possessing none but true joints.

The Axis or vertebra dentata possesses a larger body than any other true vertebra and anteriorly presents a peculiar projection called the odontoid process which fits into the ring of the atlas and around which the head and atlas rotate. The superior spine is nearly as

long as the body, is convex and consists of two lateral halves united anteriorly. The inferior spine is sharp and well developed. The transverse processes are the smallest in the cervical region and single and are pierced by small foramina. The spinal canal is narrow and instead of notches there are two foramina anteriorly. In the horse the atlas and axis do not articulate above the canal, and there is considerable space between them—the atlo-axoid space—which is covered by soft structures only. Here the operation of pithing can be performed.

The Two Last Segments.

The sixth cervical vertebra has a much shorter body than those anterior to it and has no inferior spine. The transverse processes consist of three lateral divisions, and the foramina, notches and canal are of great size.

The seventh is the shortest of all, is very strong, with elevated neural spine pointed upwards and forwards, but scarcely any inferior spine. Its transverse processes are small and have usually no vertebral foramina, while the notches and canal are large, on each side of the body posteriorly it presents a depression for articulation with the first rib. It closely resembles the first dorsal vertebra.

Dorsal Vertebrae.

The dorsal vertebræ are eighteen in number (rarely nineteen) always correspond in number to the pairs of ribs, and in the horse form the weight bearing portion of the column, extending over the whole length of the chest. Their bodies, the smallest of the true vertebræ, are short and thick and somewhat semicircular, each presenting a middle ridge along its under surface. The anterior surface convex and the posterior concave. The transverse processes are small and each presents a facet postero-inferiorly for articulation with the tubercle of the next anterior rib. The superior spines are larger than in any other region and vary in size, shape and direction; the first twelve are directed backwards, the next three nearly upright, and the last three forward; the length increases to the fifth and then decreases to the fourteenth which is generally shorter

than those behind it. The articular processes, arch and neural canal are small. An ordinary dorsal vertebræ has twelve articular surfaces, viz.: 3 anterior, 3 posterior and 3 on each side; of the latter two are for the heads of two ribs and the third for the tubercle of the anterior rib. The 18th segment being attached to but one rib on each side has but eight articular surfaces. The first 13 form the skeleton of the withers, and, when well developed, the height of their spines increases the surface for muscular attachment and also affords greater leverage.

Lumbar vertebrae.

These form the skeleton of the loins, and are shorter in the horse in proportion to his size than in any other animal. Their number is usually six, sometimes five. Their bodies are thick and strong, the anterior surfaces are more convex and their posterior more concave than in the dorsal region. The arches enclose a large canal and have, with one or two exceptions both anterior and posterior notches, the neural spines are strong, broad and flattened laterally and have sharp anterior and posterior edges with roughened expanded extremities. The transverse processes are longer than in any other region, extend nearly horizontally to the bodies and are broad and flat with rounded extremities, the last two articulate with each other and sometimes in old age unite by ossification, the last articulates in a similar manner with the sacrum. The first four have six articular surfaces, the fifth 8, and the sixth 10.

False Vertebrae.

The Sacrum. The bone of the croup is a single, somewhat triangular bone consisting of five false vertebræ united in the young animal by articulation, in the adult by ossification. It contains the continuation of the spinal canal, forms the roof of the pelvis and has articular surfaces by which the pelvic arches are attached. (Its direction varies somewhat according to the breeding of the animal. In well bred animals its long axis is placed in a nearly horizontal line, while in coarser bred animals it often declines from before backwards giving a drooping appearance to the croup.) It presents for consideration superior or inferior surfaces

two lateral borders and anterior and posterior extremities. The superior surface is irregularly convex with flat-topped spines decreasing in height but increasing in breadth as they extend backwards. The inferior surface is smooth and rather concave, and crossing the bone transversely are four slightly elevated lines, making the connections between the segments. Between these lines are four large foramina and at the anterior end two notches

The anterior extremity is almost entirely articular. The posterior extremity presents the diminished spinal canal in its centre, and below the flat surface which articulates with the first bone of the coccyx, and above the last spinous process while the notches are on each side. The *lateral borders*, anteriorly, are roughened for the attachment to the iliac bones under which they lie. Posteriorly they are roughened for the attachment of the sacro sciatic ligaments and terminate in small transverse processes. The Sacrum has five articular surfaces on its base, one on each side and one on its apex.

The Coccyx.

The coccygeal are false vertebræ varying in number from 13 to 20, are very rudimentary in form, are oblong, mostly constricted in the centre and expanded where they articulate with each other. The four or five anterior ones are slightly flattened above and generally possess incomplete arches and processes, the remaining segments merely consist of bodies which diminish in size posteriorly. There is no complete neural canal, the first two or three sometimes have their neural arches complete.

The Thorax.

The dorsal vertebræ superiorly, the ribs and their cartilages laterally, and the breast bone inferiorly, form the skeleton of a large cavity called the Thorax or thoracia cavity.

The Ribs.

In the horse the ribs usually number 18 on each side. They extend in a series of arches of varying curvature

from the dorsal vertebræ above towards the sternum and sides of the abdomen below. Their shape, in a great measure, determines the conformation of the thorax; they protect its contents and aid in its contraction and expansion. To the distal end of each rib an elongated piece of cartilage (the costal cartilage) is attached, and eight of these connect the eight anterior, called sternal or true ribs, with the sternum. The ten posterior ribs, having only an indirect sternal attachment are known as asternal or false ribs. The ribs pass first outwards and backwards and then in an arched direction downwards, their cartilages inclining inwards and forwards. They gradually lengthen from the first to the ninth, then progressively shorten. Their curvature increases from the first, which is nearly straight, to the last, which forms a large segment of a comparatively small circle. The greatest breadth is attained in the 5th, 6th, 7th and 8th, which in their middle portion exhibit the more especial characters of flat bones. Each rib presents for consideration superior and inferior extremities, and a shaft or body having anterior and posterior borders and external and internal surfaces. The superior or proximal extremity consists of a head, a neck and a tubercle. The head presents two articular convex surfaces, one directed forwards and inwards and the other backwards and inwards, and articulate with the vertebra. The neck is the constricted portion supporting the head. The tubercle is a prominent eminence at the posterior part of the neck, it has a flat facet which articulates posteriorly with the transverse process of a vertebra. External to the tubercle is an eminence, the angle, where the rib is suddenly bent downwards. The inferior or distal extremity is expanded and joined firmly to its cartilage. The anterior border is rough and excavated along its upper third to give attachment to the intercostal muscles. The posterior border is grooved along its upper third for the intercostal muscles, nerves and blood vessels. The external surface is convex in every direction; between the head and the angle it is roughened for muscular attachment. The internal surface is concave from above downwards and convex from side to side and is smooth, and mostly covered by pleura. With the exception of the last and sometimes the last two, each rib has its

cartilage. Those attached to the sternum are smallest at their proximal ends, becoming expanded before attachment to the sternum, while those of the false ribs are largest at the proximal ends, tapering to points below, pass downwards and forwards overlapping each other. Each true rib has 4 articular surfaces, two on the head, one on the tubercle and one at the distal end.

Sternum.

The sternum, or breast bone, is placed in the inferior longitudinal line of the body at the antero inferior part of the thorax. The anterior portion somewhat resembles the keel and cut water of a boat; it is elongated and concave above, convex below, with its anterior part flattened laterally and its posterior part flattened above and below. It is constructed of six or seven irregularly formed segments or sternebræ, united by cartilage in the young and by partial ossification in the adult animal, (complete ossification seldom or never takes place in this bone). Its anterior end is surmounted by the cariniform cartilage and its posterior extremity prolonged by the ensiform or xiphoid cartilage. The superior surface is triangular and concave, the inferior surface is narrow and convex anteriorly, the centre presents a prominent ridge coated with cartilage. The sides are flat and irregular and present between the segments depressions for articulation with the costal cartilages.

The cariniform cartilage presents a convex border looking forwards and upwards; latterly it is flattened, and its inferior border, prolonged over the first segments of the sternum, ends in the cartilaginous ridge. The ensiform cartilage is somewhat heart shaped, the apex being directed downwards and backwards. Its superior surface is broad and cup-shaped, its inferior surface is convex.

The bony frame work of the thoracic cavity bears some resemblance to a truncated cone with its apex or anterior extremity compressed laterally. The anterior aperture is a triangular space, with its apex directed downwards and slightly forwards, formed by the sternum, the first pair of ribs and the first dorsal vertebra; it gives passage to the œsophagus, trachea, nerves and

blood vessels. The base or posterior aperture is oval and slopes obliquely downwards and forwards from the vertebræ; it is formed by the last dorsal vertebra, the last pair of ribs, the cartilages of the false ribs and the ensiform cartilage. Its boundaries give attachment to the diaphragm, a large muscular curtain which divides the thorax from the abdomen.

The Skull.

General View. The skull articulates with the atlas from which it is suspended. Its position varies with the attitude of the animal but in our descriptions we shall always suppose it to be placed in a horizontal position. In the young animal it is composed of a number of bones, all of which, with the exception of the lower jaw, the teeth, the bones of the tongue and ossicles of the ear unite by ossification in the adult. Excluding the teeth and the internal bones of the ear there are 36 bones in the skull, 6 single, the rest in pairs.

The skull is divisable into two parts, the cranium and the face. The former is a cavity situated in the supero posterior region of the skull and continuous with the spinal canal, it contains the brain and its appendages and in the horse is comparatively small, occupying about one-fifth of the skull. The remaining bones form the face. In early life the bones of the head are united by sutures, or interposed layers of fibrous tissue, and after union by ossification a line usually indicates the position of the late suture. One of the principle sutures is the longitudinal which extends in the median line from the poll to the nasal peak, and marks the division of the skull into two lateral halves.

In describing the skull we will suppose it placed in a horizontal position resting on the lower jaw and divided into superior, inferior, lateral, anterior and posterior regions.

The superior region is a surface formed by 3 pairs of bones, the parietal, frontal, and nasal, each bone being joined to its fellow by a part of the longitudinal suture. The parietal bones are the hindermost of the three, are convex, and form part of the roof of the cranium or brain cavity, the frontal pair are flatter and very broad

above the level of the orbits, the region of the forehead. The nasal bones together form a semi-cylinder, and gradually diminish in breadth anteriorly, forming the nasal beak. The prominent transverse ridge bounding this region posteriorly is the occipital crest.

The inferior region presents a very irregular surface, bounded below by the inferior maxilla or lower jaw, a bone whose two segments are firmly united anteriorly, but diverge backwards in the form of a letter "V" each terminating superiorly in a convex articular surface, the maxillary condyle, before which is the prominent coronoid process, the lever of the lower jaw. The diverging parts or rami of the jaw include a space called the maxillary space. We find in the anterior portion the inferior incisor teeth, and in the male the canine teeth, and in the rami the inferior molars, the space between the molars and incisors is called the interdental space and is always large in herbivorous animals. If we remove the inferior maxilla we notice the following objects: Anteriorly, the premaxilla, bearing the upper incisors and partly the canine teeth, and just behind the incissors, in the median line, a small round aperture, the foramen incisivum, while the interdental space and molar teeth are similar to those in the lower jaw. The flattened surface extending from the incisors backwards between the molars is the bony palate, formed chiefly by the superior maxilla, and bounded posteriorly by the palatine arch, which is semi-eliptical in form and marks the entrance to a large cavity above called the nasal chamber; this cavity is, in the fresh state, divided into right and left compartments by a cartilagenous septum, the septum nasi.

Between the posterior molars and the palatine arch are the two palatine foramina, behind, and bounded by the palatine arch are the entrances to the nasal chamber, right and left, called the posterior nares, and the slender median bone stretching from behind forward in the cavity is the vomer, which indicates the division of chamber into right and left fossæ. Continuous with the vomer we find an irregular column of bone reaching to the back of the skull; this column consists of three pieces, the presphenoid anteriorly, then the basi sphenoid and lastly the basi occipital. On the posterior edges of the palatine arch are two small sharp pro-

jections, the ends of the pterygoid bones, and behind them the rough palatine ridges, the posterior edges of which are formed by the pterygoid processes of the sphenoid bone, outside the base of each of these processes we have the posterior aperture of the subsphenoidal foramen. Just behind the last molar teeth are two large prominences, the alveolar tuberosities, between which, and the palatine ridges and pterygoid bones are the smooth staphyline grooves. Outside the palatine ridges are two large spaces, the orbito-temporal cavities, each of which is bounded externally by the zygomatic arch, anteriorly by the alveolar tuberosity, posteriorly by the articular surface of the squamosal bone, with which the inferior maxilla articulates, and internally by the sphenoid and palatine bones. Each cavity opens by two large apertures on the lateral aspect of the skull, the posterior portion is called the temporal and the anterior the orbital fossa.

The articular surface of the squamosal bone terminates posteriorly in a projection called the anterior mastoid process, behind and internal to which is an irregularly shaped bone, the petrosal, which contains the internal mechanism of the ear and gives attachment to the bones of the tongue (the os hyoides). Between the petrosal and the basi occipital we have a large aperture leading into the cranial cavity, the foramen lacerum basis cranii. Posterior to the petrosal bones are seen two large processes pointing downwards, the styloid processes of the occipital bone, (these must be distinguished from the small petrosal bones). Still further back we have the occipital condyles by which the head articulates with the atlas.

The *lateral surfaces* exhibits inferiorly the external surface of the rami of the lower jaw, and antero-superiorly a triangular space, formed chiefly by the superior maxilla, more or less convex but sometimes hollowed in old animals, and presenting the infra-orbital foramen in its centre. The zygomatic arch presents externally a well marked ridge or line, which is continued anteriorly by a ridge called the maxillary spine. A process thrown outwards and downwards by the frontal bone articulates with the zygomatic arch about its middle; it is called the frontal or external orbital arch and it indicates the division of the cavity within into

orbital and temporal fossæ. The orbital fossa is a conical cavity, deep in which anteriorly is a depression, the maxillary hiatus, which leads to the palatine, spheno palatine and superior dental foramina, and posteriorly another depression, the orbital hiatus, containing the optic, pathetic, lacerated and round foramina. This cavity contains the eye and muscles by which it is moved, the lachrymal gland and all accessories to the organ, together with a large portion of adipose tissue or fat.

The temporal fossa is incompletely separated from the orbital by the orbital arch. It is oval and lodges the temporal muscle and the lever process of the lower jaw, and contains many foramina.

The *posterior part or base* of the skull presents superiorly the occipital crest continued downwards by the sharp mastoid ridges. Below the crest is a broad surface, and below that in the median line is the neural canal of the occipital bone, called the foramen magnum, bounded laterally by the condyles which are flanked by the styloid processes.

The anterior part or apex, formed by the premaxilla and body of the inferior maxilla, contains the incisor teeth and is more or less rounded in profile according to the age of the animal. In front it is surmounted by the external opening of the nasal cavities. This opening, included between the premaxilla and the nasal spine, is divided, in the fresh subject into two orifices, the anterior nares.

Cavities in the Skull.

The skull contains internally the cranial cavity, the nasal fossæ or chambers, and the sinuses, which are appendages to the latter.

Cranium.

The cranium is an irregular oval cavity, the walls of which are formed by the frontal, parietal, occipital, temporal, sphenoid and ethmoid bones. It occupies about one-fifth of the skull and contains the brain and its appendages.

Nasal Fossae.

The nasal fossæ are two cavities separated in the fresh subject by a cartilaginous septum, the septum nasi, which extends from the ethmoid bone to the anterior nares. The frame work of these fossæ is formed by the nasal, the superior maxilla, the frontal and the palatine bones, the whole forming an irregular tube bounded posteriorly by the ethmoid bone, two turbinated bones being situated in each fossa. The vomer in the median line gives attachment below to the septum nasi.

Sinuses.

These are widening cavities in the bones of the face. They communicate freely with each other and with the nasal fossæ of which they may be regarded as prolongations. Usually they number four on each side, viz., the frontal, maxillary, sphenoidal and ethmoidal.

The *frontal* sinus is situated inside the inner plate of the orbital fossæ. It communicates with the maxillary sinus below by a large opening through the bony partition between them; a thick vertical plate, always imperforate, separates this sinus from its fellow.

The *maxillary* sinus situated below and before the orbit is the largest of the sinuses; a ridge which contains the superior dental canal divides it into two compartments.

The *sphenoidal* sinus is a small irregular cavity formed by the sphenoid, ethmoid and palatine bones.

The *ethmoidal* sinus, the smallest of all, is a space in the ethmoid bone.

The sinuses contain air, and are larger in the adult than in the young animal, are partially divided by imperfect septa, which run across their interior. In the fresh state they are lined by mucous membrane.

"The division of the skeleton includes the bones which belong to the limbs or extremities and those which help to join the latter to the trunk. The horse, like the majority of mammals has two pairs of legs, an anterior, fore, thoracic or pectoral, and a posterior, hind or pelvic pair, which have bones of connection, called respectively the pectoral and pelvic arches. In the horse as in many other animals, there is no articular connection between the anterior limb and the trunk,

hence the pectoral arch is incomplete. The actual attachment of this limb is entirely muscular, the body being suspended, as it were, in a muscular sling between the fore limbs."

The Bones of the Fore Extremity.

The bones we have to describe in the fore extremity are the scapula, humerus, radius and ulna; the carpus, consisting of eight bones, viz., from within outwards, the scaphoid, lunar, cuneiform, and the trapezium behind the latter, in the upper row; and the trapezoid, magnum, unciform, and the pisiform behind the trapezoid in the lower row, three metacarpal bones, two of which are imperfect; three sesamoid bones one pair and a single one, the latter called the naviculare bone, and finally, three phalanges or finger bones, viz., the os suffraginis, os coronæ and os pedis.

Scapula.

The scapula is a flat bone situated on the antero-lateral surface of the thorax with its long axis sloping downwards and forwards. It is triangular with the base turned upwards. (In the horse this bone is small but strong, it is broad and thin superiorly, becoming narrow and thicker inferiorly. Its slope is a point of importance in the conformation of an animal, and varies to some extent, but its inferior angle is situated about the level of the first rib, the posterior angle being usually at or near the level of the 6th or 7th.)

It offers for consideration 2 surfaces, 3 borders and 3 angles.

The external or dorsum surface is divided into two unequal parts by a crest called the spine running nearly the whole length, and has a tubercle at its broadest part. (The clavicle, in animals that possess one, is attached to the inferior extremity of the spine.) The hollow part in front of the spine, the antea spinatus fossa receives a muscle of the same name. The postea spinatus fossa (behind the spine) is larger, and receives the postea spinatus muscle. The nutrient foramen is in this fossa.

The internal or ventor surface is smooth and uneven, its fossa, the subscapularis, lodges the subscapularis muscle.

The superior border is nearly straight and has the cartilage of prolongation attached to it.

The anterior border superiorly is convex and sharp, inferiorly concave and blunt, terminates in the coracoid apophysis for muscular attachment.

The posterior border is blunt and rough.

The anterior angle is thin, the posterior thick. The inferior expanded, and separated from the rest of the bone by a neck, and contains an articular depression, the glenoid cavity, articulating with the humerus, and surmounted by a roughened ridge for insertion of the capsular ligament.

Humerus.

The humerus is a long bone extending obliquely downwards and backwards from the scapula to the radius. It possesses a shaft and two extremities.

The shaft is twisted, with 4 surfaces. The anterior surface is somewhat triangular with the apex downwards. The posterior is round and smooth and terminates inferiorly in two prominent ridges, the epitrochlea and epicondyle. The external surface contains the musculo spiral groove which winds obliquely downwards and forwards and is separated from the anterior surface by the deltoid ridge, which extends from the proximal end to the coronoid fossa. A rounded prominence, the external tuberosity is seen on the upper part of this ridge bending backwards over the spiral groove. The internal surface has no distinct separation from the anterior and posterior surfaces; it has a prominence, the internal tuberosity, about its middle third.

The proximal end presents the head and the trochanters. The head is convex, and larger than the glenoid cavity with which it articulates, allowing extensive and varied motion, it is surrounded by a roughened border for insertion of the capsular ligament, below which is the constricted neck of the bone.

The external trochanter has two prominences, the anterior or summit of the trochanter, which forms the external boundary of the bicipital groove gives insertion to the outer tendon of the antea spinatus muscle, while the posterior, the more prominent of the two, is

covered by fibro cartilage over which glides the tendon of the postea spinatus, which is inserted to a rough surface below.

The internal trochanter is divided into 3 parts, anterior, posterior and inferior; the anterior forms the internal boundary of the bicipital groove which is divided by a middle prominence into two channels which are covered with fibro cartilage and serve as a pulley over which the tendon of the flexor brachi muscle plays.

The distal extremity is smaller and smooth to articulate with the radius and ulna, its surface is convex and wider in front than behind. A groove, terminating in the olecranon fossa posteriorly, divides it into an internal and external condyle or trochlea, the latter being the smaller.

The Forearm.

The bones of the forearm are the radius and ulna, which in young animals are distinct, but in the adult become united by ossification and are sometimes described as one bone, the os antibrachii. We will describe them separately.

Radius.

The radius is a long bone placed vertically between the humerus and the carpus. The shaft is flattened and curved with gradually expanding extremities. Its anterior surface is smooth, its posterior concave from above downwards, and presents, towards its external border, a rough triangular surface to which the ulna is attached by interosseous ligaments in the young, and by ossification in the adult animal. The shallow, transverse groove above this surface assists in forming the radio ulnar arch, and the nutrient foramen is near this groove. The external and internal lateral surfaces are round and have no distinct separation from the anterior and posterior surfaces.

The proximal extremity is widest from side to side and presents an articular surface divided into two depressions, the glenoid cavities, which receive the condyles of the humerus, the inner is the larger, the outer has a slight eminence in its centre. A rough ridge around the surface gives attachment to the capsular

ligament, the anterior part has a prominent lip, the corocoid process, in its centre, and near the internal border the bicipital tuberosity. On each side of the articular surface is a rough portion for the lateral ligaments, the external of which is called the external tuberosity. Posteriorly two facets articulate with the ulna

The distal extremity is also widest from side to side its articular surface is divided into three facets; the internal, the largest, articulates with the scaphoid bone, the middle with the lunar, the external, the smallest, with the cuneiform and trapezium. The whole is surrounded by a ridge for the capsular ligament. The anterior part has two deep vertical grooves and a shallow oblique one, laterally two processes, the internal the larger, for attachment of the lateral ligaments.

Ulna.

The ulna is an irregular bone, triangular in form, with the base uppermost. It grows but little after birth. It possesses a body and two extremities. The body is triangular and has three surfaces and three borders. The anterior surface corresponds to the posterior surface of the radius to which it is attached, having superiorly two convex facets to articulate with the radius; below this is a rough portion for the attachment of the interosseous ligaments, and still lower a transverse groove which assists in forming the radio ulnar arch. The external surface is flattened, the lateral borders are thin, the posterior border concave and round, the distal extremity is pointed and extends a little below the middle of the radius.

The proximal extremity corresponds to the elbow of man; it projects upwards and backwards from the articular surface of the radius and is called the olecranon process. It presents two surfaces, two borders and a summit. The external surface is slightly convex and rough, and internal surface is hollow and smooth, the posterior border concave, thin and smooth; the anterior border, thin superiorly, is hollowed into a crescent shaped surface, which articulates with, or rather behind and between, the condyles of the humerus, the prominent portion is known as the beak of the olecranon. The summit is the broad rough protuberance

which gives insertion to the tendom of the triceps extensor brachi muscle, the olecranon being the lever on which that muscle acts. (It is important to note that the development of the ulna is directly proportional to the number of fingers or digits, hence the horse, being a monodactyle, has a very short ulna. While in the ox and dog it is much longer.)

Carpus.

The knee, or carpus corresponds to the wrist in man. There are seven bones in the knee and occasionally an eighth is found which is very small and called the pisiform; with this the knee consists of eight bones, named and arranged as follows in two rows:

The scaphoid occupies the inner side of the upper layer, the lunar the centre and the cuneiform the outer side. The trapezoid the inner, the magnum the centre and the unciform the outer side of the lower row. The trapezium is situated behind and articulates with the cuneiform, consequently it occupies the outer side of the knee, and the pisiform is found behind the trapezoid. These bones are all somewhat similar in character; they are irregular in shape, and possess small facets to articulate with each other and with other bones. The upper row forms an articular surface adapted to that of the lower extremity of the radius, the inferior surface of the upper row presents a slight concavity for articulation with the superior surface of the lower row. The under surface of the lower row is nearly flat and articulates with the metacarpal bones. The true carpal joint or principal seat of motion is between the radius and the upper row, there is less motion between the rows, and still less between the lower row and the metacarpus. (The lesion, termed broken knees, usually occurs where there is the most extensive motion.)

Metacarpus.

The metacarpus is that part of the skeleton which lies between the carpus and the finger, consisting in the horse of three bones, one large one and two small bones, called splint bones.

Os Metacarpi Magnum.

The large metacarpal, or canon bone is a lon straight bone, placed in a vertical direction, having flattened shaft; the anterior surface is convex an smooth and the posterior broad, flat and pierced a about the upper third by the nutrient foramen; on eac side of this surface is a vertical ridge to which the splin bones are attached.

The proximal end presents a smooth articular sur face formed by three facets corresponding to the lowe surface of the lower row of the carpus; on the intero anterior portion of the head is a prominence for th insertion of the extensor metacarpi magnus tendon On the posterior part is a rough surface from which th suspensory and cheek ligaments originate, and on each side two facets to articulate with the splint bones.

The distal end is formed by two condyles, convex from before backwards to articulate with the os suffraginis below and the sesamoid bones behind; each condyle presents a depression on its side for attachment of the lateral ligament.

Os Metacarpi Parva.

The small metacarpal, or splint bones are tuberous above and taper to a point below reaching about ⅔ down the large bone. The superior surface of each bone articulates with the carpus, the inner one has two facets and the external one but one; below the articular surfaces externally the heads are rough. The internal lateral parts of the heads each present two articular facets to articulate with the large metacarpal. The anterior surface is flat and attached to the posterior surface of the large bones, one on each side, by ligaments in young animals and sometimes by ossification in the old. The bones gradually taper to a point or apex which terminates in a small knob. (These knobs are very prominent in well bred animals and are sometimes mistaken for splints, which are exostosises between the large and small bones.)

Digit.

The digit or finger is composed of three bones placed one immediately below the other and having three

sesamoid bones behind. The joint which the large metacarpal forms with the os suffraginis and its two sesamoid bones is the fetlock joint, that between the os suffraginis and os coronæ is the pastern joint, and that between the os coronæ and the os pedis with its sesamoid or navicular bone is the coffin joint, or navicular joint.

Os Suffraginis.

The Os Suffraginis is a long bone with its shaft slightly flattened from before backwards, the anterior surface convex and smooth, and the posterior somewhat flat, presenting two rough ridges, triangular in form with the base upwards.

The proximal end presents a semi-lunar shaped articular surface consisting of two glenoid cavities for articulation with the condyles of the canon bone and a deep groove for the eminence between them, behind, on each side is a tuberosity—for ligamentous attachment.

The distal end presents two condyles divided by a groove; on each side is a depression for the attachment of the lateral ligaments.

Great Sesamoid Bones.

These bones, two in number, are placed side by side at the back of the fetlock; they are irregular in shape with smooth and concave anterior surfaces with the internal edges bevelled to articulate with the ridge of the metacarpal bone. The posterior surfaces, when in situation, form a channel which is covered with fibro cartilage for the passage of the flexor tendons. The apex and lateral borders are rough, and form a groove for the reception of the suspensory ligament. The base is also rough for ligamentous attachment.

Os Coronae.

The os coronæ is an irregular bone, with no madullary canal. The superior surface is smooth, and divided by an eminence into two glenoid cavities for the condyles of the os suffraginis. The inferior surface is smooth and convex, and divided by a depression into two condyles which articulate with the os pedis and os naviculare. The anterior surface is convex and very rough. The posterior surface is slightly excavated and

not very rough, and has on its upper part an eminence covered by fibro cartilage over which plays the tendon of the flexor pedis perforans.

Os Pedis.

The os pedis is an irregular bone situated within the hoof. It is semi-lunar in form, with the convexity in front. It is a very hard but porous bone, having many excavations and foramina for the transmission of arteries and veins. In this bone we notice the wall, the sole, the tendinous surface, the articular surface and the alæ or wings.

The wall, or anterior surface, is the semi-circular part in front and presents numerous depressions and foramina. Anteriorly it is surmounted by the pyramidal process which gives insertion to the extensor pedis tendon, in a depression on each side of which a ligament is inserted. The inferior edge of the wall is serrated and notched. At each side is the preplantar groove which ends posteriorly in a foramen of the same name. The sole or inferior surface is slightly excavated and rather smooth. The tendinous surface is the rough portion behind the sole. It presents a triangular, rough depression on its middle and anterior part, where the tendon of the flexor pedis perforans is inserted, and on each side the plantar groove, which terminates in the plantar foramen; the posterior part of this surface is rough. The articular surface presents two glenoid cavities separated by a slight eminence which terminates in the pyramidal process; this surface articulates with the os coronæ. Behind the cavities, a flat, narrow, triangular surface articulates with the os navicular.

The alae or wings are irregular protuberances on the posterior part of the wall; they are bifid, being divided by a notch, the preplantar fissure, which in old animals is converted into a foramen. The inferior and posterior portion of the ala is the retrossal process, and the superior portion the basilar process.

Os Navicular.

The navicular is an irregular bone situated with its long axis transversely behind and below the os coronæ and behind the os pedis, with both of which it articu-

lates forming the so-called coffin joint. The superior surface is smooth, with two concavities and a central eminence. The inferior surface is rather rough and has also two concavities and a central eminence covered with fibro cartilage which forms a pulley over which plays the tendon of the flexor perforans. The anterior border is divided into two portions, a superior, smooth and triangular which articulates with the os pedis, and an inferior elongated, rough and porous. The posterior border is triangular, rough and porous. The extremities are pointed and attached to the alæ of the os pedis by lateral ligaments.

Pelvic Arch.

The posterior extremity is united to the trunk by the direct articulation of the pelvic arch with the femur and sacral vertebra. The three bones which form the arch unite early by ossification and the entire arch is called the os innominatum. The two ossa innominata articulate with each other in the inferior median line, and at a later period this union also becomes ossified; the complete structure is called the pelvis, and the space which it helps to enclose is the pelvic cavity, which is the incomplete basin composed of the sacrum, part of the coccyx and the two ossa innominata, each of which is composed of three bones, viz.: the Ilium, Ischium and Pubis, which all meet in the acetabulum, or articular cavity for the femur.

Ilium.

The ilium is a flat bone situated partly upon the sacrum with which it articulates; it is irregularly triangular in shape, its extreme outer angle being one of the most prominent points of the animal, forming the point of the hip. It presents for consideration two surfaces, three borders, and three angles or processes.

The external surface is concave at its upper part, becoming convex and narrow further down, forming the upper part of the shaft of the ilium; as it approaches the acetabulum the shaft again slightly expands. This surface terminates in an obtuse angle, the outer side of which forms the anterior margin of the acetabulum; and the inner side, surmounting this cavity, marks the line of junction between the ilium and the ischium.

The internal surface is slightly convex, its upper portion consists of two parts, an outer smooth one, and an inner rough one which rests on the sacrum; on the lower portion is a line continuous with the brim of the pubis. Together these form the ileo pectineal line.

The anterior border, or crest of the ilium, lies above the sacral transverse process. It is concave above, convex below and thin in the middle. Internally it terminates in the posterior iliac spine, which forms the highest part of the hips. Externally and anteriorly it terminates in the anterior iliac spine which consists of four eminences, two superior and two inferior. They are more developed in some horses than in others and sometimes project so far as to form what is called "ragged hips."

The superior or *internal* border extends from the posterior spine to the ischium. It is sharp and thin above, becoming thicker posteriorly, presenting above the acetabulum the sciatic or superior ischiatic spine. The external border extends from the anterior spine to the acetabulum, and is concave, blunt and rough.

Ischium.

The ischium, smaller than the ilium, is a flat bone, irregularly quadrilateral, which extends from the acetabulum, and forms the posterior part of the pelvis. It presents a body, shaft and ramus.

The shaft joins the ilium at the acetabulum, it is rounded and forms the external boundary of the obturator foramen.

The body is nearly horizontal, flat, smooth, and forms the posterior boundary of the obturator foramen. Internally it is rough and joins its fellow of the opposite side forming the symphysis ischii. Posteriorly it presents a prominent projection, the tuberosity of the ischium. The ridge running forward from the tuberosity is the inferior ischiatic spine. The posterior border is thick, running from the tuberosity to the symphysis, forming with its fellow the ischial arch. The ramus, not well developed in the horse, is the small branch which joins the pubis and forms part of the interior boundary of the foramen orale.

Pubis.

The pubis is the smallest bone of the os innominatum. It is irregular in shape and forms with its fellow the antero inferior part of the pelvis. It consists of a body and a ramus.

The body reaches from the acetabulum to the median symphysis. Its superior surface is concave to receive the urinary bladder, its inferior convex and crossed by a groove from the acetabulum which contains the pubio-femoral ligament. The crest is the rough anterior border, which terminates in the symphysis. The posterior border extends to the ramus and forms the anterior margin of the obturator foramen. The outer extremity, which joins the ilium and ischium in the acetabulum is excavated to form the colyloid notch. The ramus is the flattened portion which extends posteriorly, joins the ramus of the ischium, forming part of the boundary of the obturator foramen and with its fellow the symphysis bubis internally.

Acetabulum.

The acetabulum, situated on the extero-lateral aspect of the pelvis is formed by the three segments of the os innominatum. It receives the head of the thigh bone and is one of the deepest articular depressions in the body. It is circular in outline and except at its inferior-median part is surrounded by a lip of bone. Its inferior border presents a large notch, the cotyloid notch, continued half way across the articulation as the fundus acetabuli, to give attachment to the round ligament.

Obturator Foramen or Foramen Ovale

is the largest foramen in the body, exists in each os innominata and is formed entirely by the ischium and pubis.

Pelvic or Posterior Extremity.

The bones of the hind limb are the femur, tibia, patella and fibula; the bones of the tarsus, viz., the astragalus, os calcis, one cuboid and three cuneiform bones; one large and two small metatarsals, three phalanges and three sesamoids.

Femur.

The femur or thigh bone is the largest, thickest and strongest bone in the body, belongs to the class of long bones, is placed in a direction obliquely downwards and forwards, articulating with the acetabulum and also with the tibia and patella. The shaft has two surfaces and two borders. The anterior surface is smooth, the posterior flat and expanded at its upper part and presents towards the external part of its upper third a circular roughened surface for the insertion of part of the triceps abductor muscle. The external border presents a prominent ridge, on the upper third of which is a protuberance, the trochanter minor, curved forwards. At the lower third of this border is a deep pit, the supra-condyloid fossa, and about level with this, towards the inner side, is an aggregation of tubercles forming the supra-condyloid crest.

The internal border presents near its upper third the trochanter internus, from which another ridge runs downwards, in the lower part of which is the nutrient foramen.

The proximal end terminates in the head and the trochanter major. The head is the articular surface directed forwards and inwards and is received in the colyloid cavity. It is separated from the shaft by the neck, and between the two is a roughened ridge for the attachment of the capsular ligament. There is a deep notch at the inner part of the head for the attachment of the pubio-femoral and round ligaments.

The trochanter major is a large eminence projecting upwards and outwards, the summit of which stands a little higher than the articular head. Behind the trochanter is the digital or trochanteric fossa.

The distal end presents posteriorly two condyles and anteriorly a trochlea. The condyles articulate with the head of the tibia and are separated by an intercondyloid groove, the external condyle has two fossæ on the outside, the internal condyle has a prominence on its lateral surface.

The trochlea is the pully shaped part to the front of the condyles which articulates with the patella. It consists of two prominences separated by a groove.

Patella.

This, the knee-pan or stifle bone, is placed in front of the trochlea of the femur. Its anterior surface is convex and rough, its posterior surface smooth to articulate with the femur, presenting two concavities divided by a ridge, the superior surface is broad, the inferior surface rough and pointed.

Tibia.

The tibia, or leg bone slants downwards and backwards between the femur and astragalus. The shaft is three sided, presenting outer, inner and posterior surfaces, all of which are wider above than below. The outer surface is concave above and convex below and smooth. The inner surface, slightly convex from side to side, is smooth except at its superior part. It is covered chiefly by skin, facia, and strong periosteum. The posterior surface, the broadest of the three, presents on its upper third a triangular and rather smooth portion, the other two-thirds being marked by a number of longitudinal ridges.

The *proximal* end presents two large, smooth, somewhat undulated articular surfaces, divided by a rough conical process, the tibial spine. The semi-lunar cartilages are interposed between these surfaces and the condyles of the femur. Anteriorly a tubercsity, concave externally and convex internally joins the tibial ridge, and presents a vertical notch in front for the middle straight ligament of the patella. At the sides are two processes to which the lateral ligaments are attached, the external being the larger and presents an articular facet for the head of the fibula.

The distal end presents two smooth, deep articular grooves, running obliquely backwards and inwards, the internal being the deepest, the external the widest. Also three projections, the middle one dividing the grooves, is articular and continuous with them, while the others are rough outside for attachment of ligaments.

Fibula.

The fibula is a long slender bone, little developed in the horse, and is an appendage to the tibia, being attached to its outer side and extending from its head to

its lower third to which it is affixed by a ligament, the space between the bones is called the tibial arch. The head is nodular, flat and rough externally. Internally it articulates with the external lateral part of the head of the tibia. Distally the bone becomes slender and tapers to a point from which a ligament is sometimes continued the whole length of the bone.

Tarsus.

The tarsus, or hock, corresponds to the ankle of man, and is composed of six irregular bones placed between the lower end of the tibia and the superior extremity of the metatarsus. They are arranged in two series, one consisting of the cuboid and three cuneiform bones, the magnum, medium and parvum, corresponds to the lower row of the carpal bones, the other or upper series consists of the astragalus and calcaneum, the first forming with the bone above the mobile portion of the joint, may be said to correspond to the upper row of carpal bones, while the latter, being the lever bone, corresponds to the trapezium. These bones are thickly covered on their articular surface by cartilage, which acts as a protection against concussion.

Astragalus.

The astragalus or ankle bone is a pully-like bone placed immediately below the tibia with which it articulates. (A very large portion of this bone is articular.)

The supero-anterior surface presents an articular trochlea consisting of two oblique prominences separated by a groove. The inferior surface is concavo-convex. The posterior surface is very irregular and has four facets. The lateral surfaces, the internal of which presents a tubercle inferiorly, are roughened for the insertion of ligaments. (The astragalus articulates with the tibia, calcaneum, the cuboid and great cuneiform bones).

Calcaneum.

The os calcis or calcaneum forms the point of the hock and corresponds to the heel bone of man, is situated behind the astragalus snd consists of a body and a tuberosity. The body is the inferior portion flattened laterally, slightly convex externally and unevenly con-

cave internally, both surfaces being rough. Anteriorly it has four articular facets to articulate with the astragalus. Posteriorly it is convex and smooth. Inferiorly it has two facets to articulate with the cuboid. The tuberosity is oblong and flattened laterally, its external surface is rough, internally it is smooth and forms the tarsul arch, covered with fibro cartilage. Both borders are rough, the posterior one straight and gives attachment to the calcaneo-cuboid ligament, the anterior border is short and curved.

The superior extremity is expanded and roughened. Posteriorly it is covered with fibro cartilage for the passage of the gastrocnemius internus tendon. Anteriorly a small portion is also covered with fibro cartilage for the gastrocnemius externus.

Os Cuboides.

The cuboid is a small irregularly shaped bone which occupies the outer side of the hock between the os calcis and the large and outer small metatarsal bones. It presents four surfaces.

Os Cuneiform Magnum.

The large cuneiform is the bone on which the astragalus rests. It is somewhat flat and thin and presents two surfaces and a circumferent border.

Os Cuneiform Medium.

The cuneiform medium is somewhat flat and triangular and a little smaller than the magnum under which it is placed, articulating inferiorly with the large metatarsal.

Os Cuneiform Parum.

This is a very irregular bone, the smallest in the hock, at the postero-internal part of which it is placed. It articulates with the large and medium cuneiform bones and with the large and internal small metatarsal bones.

Metatarsal Bones.

The large metatarsal bone presents the same general appearance as the large metacarpal, but is about one-sixth longer, flattened laterally, and rounded, and

more prominent anteriorly. The inferior extremity is larger and thicker than the superior. The small metatarsals also resemble the small metacarpals but are longer and larger, the external being the longest.

The remaining bones of the hind extremity so closely resemble those of the fore, that no description is necessary except to mention that the first and second phalanges are a little longer.

Comparative Osteology.

We will now mention some of the chief differences in the bones of the horse and the ox.

In the cranium of the ox an important feature is the development of the frontal bone, which extends from below the eyes to the back of the skull, forming the entire forehead and crest, in the middle of which is the frontal tuberosity, which is very large in hornless animals. Springing from the sides of the crest are two processes, varying in size and curvature, but corresponding to the shape of the horns which they support. These are the flints or horn cores which are porous in their structure, especially at their roots. They are covered with thick periosteum, and contain sinuses which are continuous with the frontal sinuses.

The parietal bone is placed below the frontal crest extending under and supporting the cores.

The occipital bone is single, wider from side to side, but smaller than in the horse, and has neither crest nor tuberosities.

The squamosal and petrosal bones are united into a single temperal bone.

The nasal bones are shorter and broader.

The superior maxilla is shorter and broader.

The premaxilla is shorter and broader, its inferior surface is flat and destitute of aveolar cavities.

The inferior maxilla is longer but less massive, the neck more constricted, and the symphysis seldom becomes completely ossified. There are eight small alveoli in front for the incisors and canines, the latter being close to the former.

The true vertebral column is made up of 26 segments, 7 cervical, 13 dorsal and 6 lumbar. The bodies of the cervical are shorter than those of the horse; the dorsal longer; the sacrum is large and more arched; the

coccygeal, 13 to 20 in number, are stronger and more tuberous.

The ox has 13 pairs of ribs, 8 true and 5 false. They are straight, broad and long, and more uniform than in the horse. The distal ends are expanded to articulate with their cartilages by means of true joints. The sternum is large and flat, consisting of seven pieces, all of which unite by ossification except the first and second, between which there is a true joint.

The os innominatum is larger but presents the same general apperance as in the horse.

The femur is distinguished from that of the horse by the trochanter minor being missing. The head is small but prominent; the trochanter major has but one eminence.

The tibia has no articular facet for the fibula and the distal end has its external mallealus detached, forming a small bone called the malleolar bone. The fibula is wanting, being replaced by a ligament stretching the whole length of the bone.

The patella is small and somewhat conical in shape.

The tarsus consists of five bones. The astragalus is deep but narrow, having a pulley shaped surface inferiorly as well as superiorly. The calcaneum is long and square. The cuneiform magnum and cuboid are united forming the cubo-cuneiform bone; the medium is like that of the horse, while the parvium is very small.

The large metatarsal has its inferior extremity divided into two equal parts by a deep fissure with a groove superiorly. The small metatarsals, when present, are rudimentary and single.

The scapula is large and very triangular. The spine does not terminate gradually in the neck, but by an abrupt angle, prolonged to a point, the acromion process; the neck is more distinct and the coracoid process and glenoid cavity are small and close together.

In the humerus the bicipital groove is single, the external trochanter very large and the shaft is less twisted than in the horse.

The radius is short, the ulna longer and larger, extending to the distal end of the radius and articulating with the cuneiform bone. There are two radio-ulnar arches connected by a deep fissure.

The carpus consists of six bones, four above and tw
below.

The large metacarpal presents a vertical groove dow
its anterior middle.

The inferior extremity is divided by a deep fissu
into two articulations, each resembling the single on
in the horse, the external one being the smaller.
rudimentary metacarpus is placed postero-superiorly.

The phalanges and sesamoids in either limb ar
double, one set forming each digit; they are small an
narrow. The coffin bone or os pedis resembling half o
that of the horse mesially divided.

In the adult ruminant two bones are commonly foun
in the heart called the cardiac bones or ossa cordis
They are found related with the auriculo-ventricula
rings. They present 3 angles, 3 borders and 2 sur-
faces, the left being considerably the smaller.

Arthrology.

The several bones which form the skeleton are unite
by means of certain soft structures, forming a series o
articulation or joints, the study of which is called arth-
rology or Syndesmology.

Before considering the different kinds of joints we
will briefly describe the various tissues, other than
bone, which enter into, and contribute towards their
formation. These are chiefly cartilage, connective and
elastic tissues, and fat.

In health one bone never comes directly in contact
with another, cartilage or fibrous tissue being always
interposed. An exception to this exists in the adult
skull, most of the bones of which become firmly united
by ossification of the interposed soft material.

Cartilage.

Cartilage, known also as gristle, is a firm, bluish-
white, elastic animal substance, flexible and possessing
great cohesive power. That which becomes converted
into bone is called temporary, and that which persists
as cartilage in the adult, permanent cartilage, and it
never, under any circumstances, ossifies.

Cartilage consists of corpuscles or cells, usually em-
bedded in an intercellular substance or matrix. These
cells are oval or round, and nucleated, the nuclei, which

appear under the microscope as small spots, containing still smaller spots called nucleoli.

There are three varieties of permanent cartilage, viz., hyaline, fibro and cellular. In the first the matrix is homogeneous, or void of definite structure, appearing slightly granular under the microscope. Fibro-cartilage is characterized by a matrix of fibrous tissue, while cellular cartilage consists of an aggregation of cells without a matrix.

Hyaline cartilage is distinguished by the following names according to the purpose it serves: Articular, when it encrusts the articular surfaces of bones; Costal, when it supplies elastic prolongations to the ribs; Membraniform, when it appears as thin plates, forming permanently open tubes. (The trachea or wind pipe is formed of this kind). Articular cartilage in the adult is nonvascular, being nourished by a vascular zone in the synovial membrane.

Fibro-cartilage consists of cartilage cells and fibrous tissues, which may be white or yellow, the former being tough and strong and the latter highly elastic. White fibro-cartilage is much the more abundant and presents the following varieties: It is called inter-articular when it appears as a pad interposed between the two articular surfaces which form a joint. Such a pad is termed a meniscus. The temporo-maxillary and femoro-tibial joints are furnished with such. Circumferential, where it surrounds and deepens an articular cavity, as the acetabulum. Connecting, where it is interposed between bones, firmly connecting them, as between the vertebral centra. Stratiform, or investing, when it clothes the parts of bones over which the tendons of muscles play. (Yellow elastic fibro-cartilage is found in the epiglottis, in the framework of the ear, and the Eustachian tubes. Cellular cartilage is found in the ear of some rodents and in the bat.)

Connective tissue, in one form or another, is found in all parts of the body. The chief varieties are the areolar and the fibrous, the former serving as a connecting medium and support to the various organs, and to the structures of which they are formed. It appears as a loose translucent mesh, its interwoven bundles forming spaces termed the areolæ or cells,

hence its name, cellular or areolar tissue. It consi
of minute laminæ and filaments mixed with small fib
of elastic tissue, while cells or their remains, nuc
and walls, are also present.

The filaments which form it are mostly parallel a
wavy in their arrangement. It appears in two form
the sheeted or aponeurotic, which is found in investi
ligaments, membranes, periosteum, &c., and the cord
form, in which the fibres are collected in strong bu
dles, as in binding ligaments and tendons. Connecti
tissue contains nerves and blood vessels. Whe
healthy it is little sensitive to pain.

Yellow elastic tissue differs from the white fibro
by being yellow, elastic, and not so tough and stron
the fibres branch and join each other and their en
curl up when cut or broken. It is found in the liga
mentum nuchæ, coats of arteries, &c.

Adipose tissue consists of cells containing an oil
material, and arranged in isolated groups or slightl
separated by meshes of areolar tissue. It is found i
many parts of the body, and varies greatly in quantity
In joints it occurs between the ligaments, and serves a
a packing material, while in the form of marrow i
occupies the cavities of bones.

Ligaments.

Ligaments are dense, fibrous, connecting structure
existing in most articulations, and are principally mad
up of white fibrous tissue. They are of two kinds, viz.
capsular or bursal and funicular or binding. Capsula
ligaments are membranous structures enclosing true
joints. Funicular or binding ligaments consist o
rounded or flattened cords, or bands of fibrous tissue
passing from one bone to another, firmly attached t
roughened portions on their surfaces. Ligaments
which are situated between the bones are termed inter
osseous. Annular ligaments are those which bind down
and protect the tendons of muscles in certain joints.
Some ligaments are composed almost entirely of yellow
elastic tissue (such as the ligamentum nuchæ.)

Synovial Membranes.

These are thin membranes lining the capsular ligaments of joints, or they are interposed between structures which move one upon another. They secrete a fluid, called synovia or joint oil, and they line closed cavities, resembling what are called serous membranes. There are three forms of these membranes; the capsular, which line the capsular ligaments of the joints; bursal membranes, where one structure moves upon another (as where a tendon plays over a bone) and are known as synovial bursæ; when they exist between the skin and certain prominent parts of the skeleton they are known as bursæ mucosæ. The third form, vaginal membranes or sheathes, exist where one tendon forms a sheath for another, or in other canals in which tendons glide. Synovia or joint oil is a viscid, transparent fluid, colorless or pale yellow, resembling oil, but it contains very little fatty matter, consisting chiefly of albumen, salts and water. When an animal is in active exertion there is a greater demand for joint oil than when at rest, consequently there is an increased secretion of it.

Classes of Joints.

Joints may be divided into three classes. Immovable or Synarthrodial. Movable or Diarthrodial, and Mixed or Amphiarthrodial. In an immovable joint there is only a thin layer of fibrous or cartilagenous material interposed between the bones. These joints are chiefly, but not solely, found in the skull. The varieties are sutura, synchondrosis, schindylesis and gomphosis. Sutures are true and false. Variety of shape has led to the following nomenclature; sutura dentata when the processes are large and tooth-like as in the interparietal; sutura serrata where they are small and fine, like the teeth of a saw, as in the interfrontal; and sutura limbosa, where the contiguous parts are dentated and also bevelled, as in the parieto-occipital.

In the false sutures the bones are joined by plain, rough surfaces, of which there are two forms; sutura squamosa, where the adjacent borders are bevelled, the edges of one bone overlapping the other as in the parieto-temporal, and sutura harmonia where the articulating

surfaces of two bones present no marked irregularity as the nasal and premaxilla.

Synchondrosis resembles a sutura, but the connecting medium is cartilage instead of fibrous tissue (as between the basi-occipital and the basi-sphenoid.)

Schindylesis is that form where a ridge or plate of one bone is received into a slit or fissure of another, as the orbito-sphenoid into the incisura sphenoidalis of the frontal bone.

Gomphosis is the form where one bone is inserted into a cavity or socket in another, as the teeth in the alveoli.

Diarthrosis.

In diarthrodial or true joints the articular surface of each bone is covered by cartilage of encrustation. The bones are held together by ligaments, the capsular one enclosing the cavity of the joint. In some joints there is a pad of fibro-cartilage interposed between the two articular cartilages, called a meniscus, which adds to the freedom and elasticity of the joint.

The chief varieties of true joints are arthrodia, enarthrosis and ginglymus.

In arthrodia the motion is slight and gliding, as in the small bones of the knee and hock.

Enarthrosis, the ball and socket joint, is capable of moving in any direction, as the shoulder and hip joints.

Ginglymus, or hinge joint, although it may admit of extensive motion is limited to one plane, backwards and forwards, as in the elbow.

A rotary joint (diarthrosis rotatorious) where the motion is limited to rotation, is formed by a point of one joint fitting into a ring on another (as the alto axoid joint).

Amphiarthrosis.

There is but one form of mixed joints. The term is used with reference, not to the motion, but to the structure, which partakes of the nature of both movable and immovable, the bones being joined firmly together by a strong interposed pad of fibro cartilage which is likewise adherent to the ligaments of the joint. There is no capsular ligament. Authorities differ as to whether there are synovial membranes. The joints between the vertebral centra are the best examples.

Table for Reference.

- Synarthrosis (Immovable)
  - Sutura
    - Vera
      - Dentata
      - Serrata
      - Limbosa
    - Notha
      - Squamosa
      - Harmonia
  - Synchondrosis
  - Schindylesis
  - Gomphosis
- Diarthrosis (Movable)
  - Arthrodia
  - Enarthrosis
  - Ginglymus
  - Diarthrosis rotatorius
- Ampharthrosis (Mixed)

Motion in Joint.

The following terms express the various motions allowed in joint:

Extension tends to bring two bones as nearly into a straight line as the structure of the joint will permit.

Flexion is the reverse of this.

Abduction expresses the outward movement of a limb or bone from the central plane of the body.

Adduction is the reverse movement of this.

Rotation signifies the partial revolution of a bone or number of bones, as it were, on their own axis.

Circumduction implies the movement of the distal end of a bone or limb when it describes a curve.

The term gliding describes itself.

Ligaments of the Vertebra.

All moveable joints are connected by ligaments, some of which are common, others special. The former are continuous, passing over, and uniting many vertebræ, while the latter exist separately between the contiguous segments. The common ligaments are superior and inferior common, and the supra-spinous ligaments, the latter in the cervical region being called the ligamentum nuchæ. The superior common ligament extends in the spinal canal from the sacrum to the axis, placed upon the superior part of the bodies of the

vertebræ. The inferior common ligament situated below the vertebræ, stretches from the sacrum only to the sixth dorsal. Posteriorly the supra-spinous ligament is a white fibrous cord, extending from the spine of the sacrum along the upper margins of the neural spines to the first dorsal vertebra, where it changes its character to yellow elastic tissue and becomes the ligamentum nuchæ, extending forward to the tuberosity of the occiput. It consists of a funicular and a lamellar portion. The former is double and extends from the first, second and third dorsal spines to the tuberosity of the occiput, continuous posteriorly with the white supra-spinous ligament, in which yellow elastic tissue can be traced for some length. The right and left segments meet in the median line, and from the postero-inferior aspect springs the lamellar portion, which is flat and triangular, separating the muscles of the neck into right and left. It consists of two plates joined by cellular tissue, the bands descending from the cord and spinous processes usually of the three first dorsal vertebræ, run obliquely forward, to be inserted to the superior spines of the six posterior cervical vertebræ. This ligament is not a binding ligament. It is highly elastic and acts as a passive support to the head and neck, diminishing the muscular tension of the superior cervical region.

Some of the joints of the limbs have common ligaments, they all have special ones, with the consideration of which I will not burden you, but will just state that all the movable joints have capsular ligaments, most of them lateral and some interosseous. I may just mention some of the chief differences between the loints and ligaments of the ox and the horse.

In the ox the sternal ribs articulate with their cartilages by means of true diarthrosis, and are supplied with synovial membranes. The first segment of the sternum articulates with the second by means of a true joint. The pubio-femoral ligament is wanting in all the domesticated animals except the horse.

Myology.

The branch of anatomy which treats of the muscular system is called myology. The muscles are the active organs of motion or of locomotion, the bones and liga-

ments being passive organs of the same. In order to understand their working it will be necessary to take a brief view of their anatomical and histological structure. They contain a specific contractile substance called muscular tissue, together with areolar and fibrous tissue and a certain amount of fatty material. They are also furnished with nerves, blood vessels and absorbents.

There are two varieties of muscular tissue, viz., the striped or striated or voluntary, and the unstriped or involuntary, the contraction and relaxation of the former being, with little exception, controlled by the will of the animal, the latter being beyond the control of the will. The chief exception to this general distinction being found in the heart and the upper part of the œsophagus which contain involuntary striated muscular tissue. Both varieties are red in color but the hue of the striated kind is much the deeper.

Voluntary muscular tissue forms the mass of the so-called muscles, which terminate at either extremity in fibrous structures called tendons, by means of which they are attached to bones, the fleshy portion is called the belly of the muscle.

A muscle is composed of bundles or fasciculi of fibres. The microscope shows these fibres to consist of fine filaments termed fibrillæ, which run parallel to each other. Each fibre is enclosed in a delicate tubular sheath called the sarcolemma or myolemma, composed of a transparent, tough and elastic membrane which isolates each fibre. The fibres, about 1-500 of an inch in diameter, are gathered into fasciculi, and invested with a sheath of connective tissue which is reflected between the fibres, called the perimysium internum. The entire muscle has likewise an investing sheath of connective tissue, the perimysium externum, continuous with the above. A muscular fibre, examined under the microscope will display the transverse, waving lines or striæ from which the name striated is derived. Longitudinal markings are also often apparent but less regular than the striæ.

Non-Striated Muscular Tissue,

or involuntary muscular tissue is pale in color, and consists of fibres bound into fasciculi by areolar tissue.

The fibres never terminate in tendons and are not invested in sarcolemma. They are cylindrical in shape, and composed of elongated cells in which a nucleus is present. The contractile power exists in the cells. This tissue is very abundant, being found in the walls of the alimentary canal and hollow viscera, in gland ducts, the coats of blood vessels, the skin and elsewhere.

Both forms of muscular tissue are supplied with blood vessels and nerves. The nerves of the voluntary form coming from the cerebro-spinal system, and those of the involuntary from the sympathetic system.

Tendons.

The tendons in which voluntary muscles terminate at either end resemble ligaments in their composition, being formed of white fibrous tissue mixed with yellow elastic fibres, they are practically non-elastic. The extremity of a muscle which has the most fixed attachment is called its origin, the other extremity its insertion. The tendon of insertion is usually the longer. The tendons are prolongations of the coverings of the fibres and fasciculi at each extremity.

Fascia.

Each group of muscles is invested and bound down by a strong expansion of white fibrous tissue called fascia, which is firmly attached to the bone. This term is also applied to a membranous expansion below the skin which forms a continuous covering over the whole body, composed of connective tissue more or less condensed, this is called superficial fascia.

Aponeurotic fascia is that form which covers, supports and binds down groups of muscles; it unites to, and blends with the periosteum. Fascia is also found in connection with the walls of cavities, as in the pelvis. (In the limbs where muscles form lengthy masses, with long tendons, there would be considerable displacement during motion, were it not that in these parts the fascia is very strong.)

Muscular Nomenclature.

Some muscles are named from their form, others from their use, others from their situation, others from their direction, others from their attachment, &c.

Time will not allow us to enter into an exhaustive study of the individual muscles, but we will consider some of the most important ones.

Particular Muscles.

The *Panniculus Carnosus* is spread over the greater part of the body, as the face, neck, thorax and abdominal portions, these being all continuous. It is, as a whole, aponeurotic superiorly, becoming more fleshy as it descends. It is related with the skin externally; internally with the superficial layers of muscles. Its action is to corrugate the skin, and thus enable the animal to expel insects and irritating bodies.

The *Obliquus Abdominis Externus* is situated on the infero-taleral aspect of the abdomen. It is attached to the outer surface of the last fourteen ribs, just below their middle, to the fascia of the latissimus dorsi, and superiorly to the lumbar fascia, to the anterior spine of the ilium, to the pelvis, and to the linea alba throughout its whole extent. Its action is to support and compress the abdominal viscera, and assist in defecation, urination and parturition. It is also a flexor of the vertebral column, and a muscle of expiration. There are also the obliquus abdominis internus, rectus abdominis and transversalis abdominis which have a similar action.

Antea and *Postea Spinati* muscles occupy the fossæ of the scapula, and the antea is inserted inferiorly by two tendons to the internal and external trochanters of the humerus, its action being to extend the humerus on the scapula, and to bind the joint like a ligament. The *postea* spinatus is inserted inferiorly by two tendons, one of which is attached to the inner side of the convexity of the external trochanter, the other passes over the convexity and is attached to the ridge below. Its action is to abduct the humerus and rotate it outwards.

The *Flexor Brachii* is the analogue of the biceps in man, and is situated in front of the humerus, is attached superiorly to the coracoid process of the scapula,

and passes over the bicipital groove, where there is a synovial bursa; and is attached inferiorly to the antero-internal part of the radius. Action, to flex the radius on the humerus and extend the latter on the scapula.

The *Levator Humeri* occupies the infero-lateral part of the neck, extending from the back of the head to the arm. It is attached anteriorly to the crest of the occiput, and mastoid process of the temporal bone, and the wing of the atlas; to the transverse processes of the second, third and forth cervical vertebræ and the fascia of the neck. Inferiorly to the deltoid ridge of the humerus, and the fascia of the muscles of the shoulders and arm. Action, when the head is fixed it advances the entire limb. If the limbs are fixed it aids in turning the head and neck to one side, or, with its fellow, in depressing them.

The *Extensor Pedis* is attached superiorly to the external condyle of the humerus, to the outer and upper part of the radius; and inferiorly to the lower part of the os suffraginis, os cornea and the pyramidial process of the os pedis. Its action is to extend the fore foot and pastern, and at the same time assist in extending the knee.

The *Flexor Pedis Perforatus* is attached superiorly to the lower side of internal condyle of the humerus; and inferiorly to the upper and back part of os coronæ. Its action is to flex the fetlock and pastern joints, and assist in flexing the knee.

The *Flexor Pedis Perforans* is attached superiorly to the same as the preceding muscle; and inferiorly to the posterior concavity of the os pedis. The tendon passes down the back of the limb anterior to the perforatus, and passes through the latter near its insertion. Its action is to flex the joints below the carpus and assist in flexing the latter.

The *Diaphragm* is the muscular partition which separates the thoracic from the abdominal cavity. It slopes obliquely downwards and forwards and is in form elliptical or heart shaped, being wider superiorly. The thoracic portion is convex, and lined by pleura, the abdominal concave and lined by peritoneum. Its centre is tendinous, and its periphery muscular. It is divided into a body and two crura. It is attached anteriorly

and inferiorly to the cartilages of the last 12 ribs, also to the ensiform cartilage; and posteriorly and superiorly to the bodies of the lumbar vertebræ. Near its centre, and a little to the right is a large opening called the foramen dextrum, through which passes the posterior vena cava. Between the pillars superiorly is a second opening, the hiatus aorticus, through which passes the posterior aorta, vena azygos, and thoracic duct. Below this is the foramen sinistrum for the passage of the œsophagus.

The *Linea Alba* is a white fibrous cord or band, attached anteriorly to the inferior surface of the ensiform cartilage, and posteriorly it unites with the prepubian tendon which is attached to the anterior border of the pubis, and assists in forming the inguinal canals. Between its posterior and middle thirds the linea alba is enlarged, and forms a space, in the centre of which is the remnant of the umbilicus. It gives attachment to the abdominal muscles.

Digestive Organs.

Before describing the anatomy of the digestive, respiratory, urinary and genital systems, it will be advisable to allude briefly to certain tissues and structures which are closely associated with them. They are, epithelium, mucous and serous membranes and glands.

Epithelium is a cellular tissue, which, in one form or another, covers all the free surfaces of the body, that is, the skin and mucous membranes; one variety of it also covers the inner surfaces of closed and airtight membranes, this is called endothelium. The following varieties of epithelium are described, viz., squamous, columnar, spheroidal and ciliated. Squamous consists of flattened scaly cells. Endothelial cells are of this variety. In columnar epithelium the cells are cylindrical in form, and arranged side by side, with their long axis perpendicular to the subjacent surface. Spheroidal epithelium is found in the follicles and ducts of glands, and is called glandular epithelium, it is also spherical in shape. Ciliated epithelium consists of columnar cells, provided at their free extremities with delicate hair like processes or cilia, which wave to and fro in a marked manner. This form is found in the

mucous membranes of the air passages, where its cilia tend by their motion to expel particles of foreign matter which may be inhaled by the breath.

Mucous Membranes.

This structure is widely diffused, lining the canals of the four systems under consideration, and being continuous with the skin at each of their orifices. A mucous membrane consists of one or more layers of epithelial cells placed upon a modified form of connective tissue, and serving as a matrix in which are situated the nerves and vessels of the membrane, along with numerous glands. The secretion of the glands proper to the mucous membranes is mucous, a viscid fluid which lubricates their free surfaces. The surface of a mucous membrane may be smooth, as in the air passages, or it may be papillated, that is, furnished with small projections called papillæ, as in the tongue. It may be rugeous, or thrown into folds or rugæ, as in œsophagus and stomach. In the small intestines it presents small finger-like projections called villi. It is then said to be villous, and in the same situation the membrane presents valve-like folds and may be termed valvular.

Serous Membranes.

The closed cavities of the body are lined by structures of this class. By a closed cavity we mean a receptacle, impervious, under normal conditions, to the atmospheric air. A serous membrane consists of an endothelial and subendothelial portion. A serous membrane is arranged so as to line a closed cavity, and at the same time cover its contents, hence it follows that the entire membrane must form a closed sac. The fold of the membrane which lines a cavity is called the parietal, that which covers its contents the visceral portion; the two surfaces contacting and gliding upon each other, are lubricated by a fluid secretion contained in the sac.

Glands are organs in which is carried on the process of secretion, or separation from the blood of certain matters which may be required to assist in the various vital functions, or to separate from the blood effete or poisonous material. Most glands resemble a mucous

membrane, consisting of epithelial, subepithelial, vascular and nervous portions. The vessels supply the glands with blood from which the secretion peculiar to the gland is separated by the vital power of the cells. The secretions of glands are, as a rule, discharged on the free surfaces of the body, that is, on the mucous membranes or the skin, by means of tubes known as gland ducts; hence such glands may be regarded as depressions in the mucous membranes or skin. The ductless glands form a group which differs from the above in the absence of a duct, the secretion being usually carried away by rupture of the glandular sac, or by absorption into the neighboring lymphatics.

The *digestive* organs comprise the alimentary canal and its accessories, by which the alimentary matter is received and subjected to specific actions which adapt it for the purposes of nutrition. The functional processes of digestion are:

1. Prehension or the taking of the food into the mouth
2. Mastication or chewing the food.
3. Insalivation or the mixing of the food with saliva.
4. Deglutation or swallowing.
5. Chymification or the conversion of the food in the stomach into chyme, by maceration and the action of the gastric juice.
6. Chylification, or conversion of the chyme into chyle, which takes place in the duodenum by the agency of the biliary and pancreatic secretions.
7. Absorption of the nutrient material into the circulation.
8. Defacation, or expulsion of the residual inert matter.

The alimentary canal is a musculo-membranous tube extending from the lips to the anus. We will consider the different parts in the order in which the food traverses them. The *mouth* contains the organs of taste and the instruments of mastication. It is situated between the jaws, is bounded in front by the lips and their aperture, laterally by the cheeks, above by the hard palate, the floor is occupied by the tongue, while the posterior boundary is the soft palate.

The *labia*, or lips, are movable fleshy curtains surrounding the anterior opening. They consist of skin

and mucous membrane, which enclose muscles, vessels nerves, areolar tissue, fat, and certain labial glands. They are the organs of touch as well as prehension.

The *buccæ*, or cheeks, resemble the lips as regards tissue, but are more muscular. The mucous coat is called the buccal membrane and is provided with buccal glands similar to the labial. The cheeks serve during mastication to support the food and press it between the molars.

The *hard palate*, or roof of the mouth, extends from the incisor teeth to the soft palate. It consists of a layer of mucous membrane, with a layer of dense fibrous tissue, firmly attached to the bony palate. It is crossed transversely with from seventeen to twenty arches with concave surfaces behind. The hard palate forms a fixed surface against which the tongue can manipulate the food.

The *soft palate*, or velum pendulum palati, "as it is called," is the valvular curtain suspended between the mouth and the pharynx, and consists of a double fold of mucous membrane, enclosing muscles, glands, vessels and nerves. It is owing to the great size of this that the horse is unable to breathe through the mouth and to resist swallowing.

The *tongue* is a movable, musculo-membraneous organ, situated on the floor of the mouth, between the rami of the lower jaw. It is the special organ of taste and at the same time materially assists in mastication and deglutation. In the ox it is prehensible, and the carnivora lap or prehend fluids with it.

The *salivary glands* are accessories of the mouth. They secrete the saliva which is discharged into the mouth, and saturates the food during mastication; during mastication these glands are very active, at other times not nearly so much so. There are three pairs, viz., the Parotid, Submaxillary and Sublingual.

The *Parotid* glands are the largest of the salivary glands and are situated in the space, one on each side, bounded by the posterior border of the inferior maxilla and the anterior border of the wing of the atlas, lying immediately below the ear. A duct, called Steno's duct, conveys the saliva into the mouth. It commences from the antero-inferior surface of the gland, passes around the ramus of the jaw, running around the anterior

border of the masseter muscle, and enters the mouth at the level of the third molar tooth.

The *Submaxillary glands* are smaller than the parotid, and lie in the maxillary space below and behind the parotid. They extend from the wings of the atlas to the body of the hyoid bone where they terminate in what are called Wharton's ducts, which open into the mouth in front of the frænum linguæ.

The *Sublingual* glands are smaller than the last named, and are situated under the tongue. In the horse they open by fifteen to twenty small ducts each, the ducts of Rivinus, along the floor of the mouth. There are several minor salivary glands, viz., the Molar, the Labial, the Linqual and the Staphyline. The Molar, so-called because they are parallel to the molar alveoli, are two in number situated in the cheeks. The Labial are situated in the lips, as the word indicates. The Lingual glands are found at the base of the tongue and partly along its sides. The Staphyline glands are situated in the soft palate.

Saliva. The saliva is a clear, viscid and colorless fluid, slightly saline in taste. It is alkaline in reaction. It consists of water with about one-half per cent. of solids, including fat, albumen and a special nitrogenous principle called ptyalin, which helps to convert starchy matter into grape sugar. It also contains alkaline and earthy salts. The food thus becomes saturated in the mouth with two fluids, mucous and saliva, both assisting in mastication and deglutation, the saliva in addition acting on the starchy constituents of the food.

Odontology, or Study of the Teeth.

Teeth. The teeth are composed of the hardest tissues of the body and consist of 76½ per cent. earthy salts. Teeth vary with the class of animal in number, size, form, structure, situation, etc., but in all cases they are in correlation with the food and generic habits of the animal. Thus in herbivora, where grinding the food is necessary, the contacting surfaces of the molars are rough and fat. In carnivora, where tearing and crushing are requisite, the molars are sharp, pointed and serrate. In omnivora, where the food is general, the teeth are mixed in their character. The form of

the teeth thus depends upon the natural food of the animal, and there is always a certain harmony between their disposition and the conformation of correlated organs. Teeth are not found in all animals. Birds have none.

Three hard substances enter into the formation of teeth, viz., Dentine, or Ivory; Enamel; and Cementum, or Crusta petrosa.

Dentine constitutes the major part of the tooth and is a hard, yellowish substance consisting of very minute tubuli embedded in a dense, granular, intertubular matrix, which contains the bulk of the earthy matter, the latter being about 30 per cent. of the whole.

Enamel is distinguished by its peculiar whiteness. It is the hardest animal texture, containing about 96 per cent. of earthy salts. No nutrient nerves or vessels have been traced into enamel, and when destroyed it is not reproduced. This tissue is protective, sometimes covering the entire exposed surface of the tooth, as in man and the dog. It also furnishes the rough projections and cutting edges found in the teeth of some classes of animals, as in herbivora.

Crusta Petrosa, or Cementum, completely covers the embedded portion of the tooth, and occupies the cavities on the free portion, where such exist. It is the softest dental texture closely resembling true bone in structure, and is of a brownish yellow color. The proportion of earthy matter is about 67 per cent., the same as in bone.

Arrangement and Kinds of Teeth.

Teeth may be simple or compound.

Simple, as in the dog, where the entire exposed surface is covered by a solid cap of enamel, which alone is in wear.

Compound, or complex, as in the horse, where various tissues are in wear.

Teeth are arranged along side of each other, so as to form the dental arches; these are interrupted at ea side, leaving the interdental spaces.

There are three kinds of teeth, viz., the incisors, or cutting teeth, situated in front of the arches; canine teeth, or tusks, in the interdental spaces; and molars,

or grinders, behind. The horse, like many other animals, has two sets; the temporary, or milk teeth, and the permanent, or horse teeth, the former numbering 24 and the latter 40. In the mare there are usually but 36 permanent teeth, the tusks usually being wanting or rudimentary. The temporary incisors are small, white, and have no grooves, and are constricted at the neck. On the table surfaces of these, when young, there are two rings of enamel, an outer and an inner ring, the space between the two being filled with dentine, while that within the inner ring is occupied by crusta petrosa, which becomes stained, constituting the so-called mark. This funnel-shaped cavity is called the infundibulum. The fangs of teeth are inserted in sockets or alveoli. The alveolar processes are the bony parts of the jaw in which the fangs are inserted. The pulp cavity runs up the fang centre, and contains a highly vascular and nervous organ, the pulp, whence the dentine of the tooth grows. It is owing to the extreme sensibility of the nerve of the pulp that toothache is so severe when the pulp is exposed. I will now mention the order and age at which teeth make their appearance.

Incisor teeth are 12 in number, 6 above and 6 below.

1. Central. 2. Lateral. 3. Corner.

Table showing number of Teeth in different animals.

	Incisors.	Canine.	Molars.	Total.
Horse,	6 / 6	2 / 2	12 / 12	40
Ox,	0 / 8	0 / 0	12 / 12	32
Dog,	6 / 6	2 / 2	12 / 14	42
Pig,	6 / 6	2 / 2	14 / 14	44
Sheep,	0 / 8	0 / 0	12 / 12	32

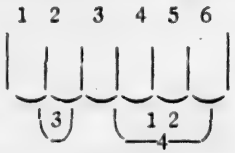
Most colts at birth have four incisors and always twelve molars. If the incisors be not present they appear at about fourteen days old. At from six to nine weeks the lateral incisors appear, and from six to nine months the corner.

Temporary Incisors. **Permanent Incisors.**

1. Birth. 2. 9 weeks. 3. 9 mos. 1. 3 yrs. 2. 4 yrs. 3. 5 years.

At from nine to twelve months the first permanent molars appear; at about two years the second. At from two and a half to three years the first two temporary molors are shed, and permanent ones take their place; and at from three and a half to four the third temporary molar is shed and replaced by a permanent one, and the sixth permanent tooth appears.

Permanent Molars.



1. 1 year. 2. 2 years. 3. 2 1-2 to 3 years. 4. 3 1-2 to 4 years.

At 5 years a horse usually gets his canine teeth.

At 6 years the marks disappear in the central lower incisors.

At 7 years the marks disappear in the lateral lower incisors.

At 8 years the marks disappear in the corner lower incisors.

At 9 years the table surface of all the lower incisors is comparattvely smooth.

At 10 years the marks disappear in the central upper incisors.

At 11 years the marks disappear in the lateral upper incisors.

At 12 years the marks disappear in the corner upper incisors.

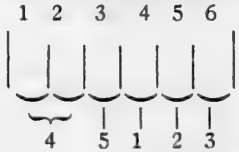
After this age, and to a certain extent after eight years, evidence of age is to be obtained from the tables of the incisor teeth, by their form, the extent of the central cavity, and the general appearance of the mouth. As a horse grows old the shape of the incisors change, they become longer, narrow from side to side and deeper from before backwards.

DENTITION OF THE OX.

Permanent Incisors.

1. From 1 year 7 months to 2 years.
2. From 2 years 3 months to 2 years 6 months, or possibly not until 3 years.
3. From 2 1-2 to 3 years. In forward animals sometimes well up at 2 1-2 years.
4. From 3 1-2 to 4 years. Not much reliance can be placed on these teeth, as they may appear any time from 2 years 10 months up to 3 years 9 months.

Permanent Molars.

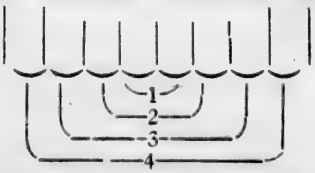


1. At 6 months.
2. At 1 year to 15 months.
3. At 1 year 8 months to 2 years.
4. At 2 years to 2 years 6 months.
5. At 2 1-2 to 3 years.

Well bred cattle get their teeth, as a general thing, earlier than common bred ones. Some have a full mouth of incisors at 3 years. Usually a full mouth of molars at 3 years.

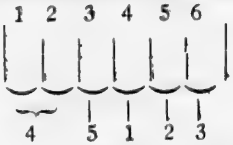
DENTITION IN SHEEP.

Permanent Incisors.



1. From 1 year to 15 months.
2. From 18 months to 2 years.
3. From 2 yrs. 3 mos. to 2 yrs. 9 mos.
4. From 3 to 4 years.

Permanent Molars.



1. At 3 months.
2. At 9 months.
3. At 18 months.
4. Shortly after 18 months.
5. At about 2 years, or shortly after the first and second.

Dentition in sheep is irregular, the same as in the ox, owing to breed, care, food, etc., well bred and well cared for animals teething earlier than those coarser bred and poorly cared for.

Pharynx. The pharynx is a musculo-membranous cavity, common to the digestive and respiratory canals. It is situated between the soft palate and the opening of the œsophagus. It has seven openings into it, viz., two posterior nares superiorly. Eustachian tubes (which lead to the guttural pouches) posteriorly, on either side; the isthmus of the mouth guarded by the soft palate anteriorly; and the openings of the œsophagus and larynx behind, the laryngeal opening being inferior.

The *Œsophagus*, or gullet, is a musculo-membranous tube passing from the pharynx to the stomach, through which the food reaches the latter. It descends the neck, at first behind the trachea, then inclines to its left, the two entering the thorax together, passes over the base of the heart, and through the diaphragm by the foramen sinistrum. Gaining the abdominal cavity it terminates in the cardiac orifice of the stomach. It consists of two tunics, an internal mucous, and an external muscular. It presents numerous longitudinal folds which allow of considerable dilatation. At the entrance to the stomach these folds form a sort of valve which prevents regurgitation of food.

Abdomen. The abdomen, or belly, contains the ultimate organs of digestion. It is a large cavity, bounded superiorly by the muscles of the sublumbar region, inferiorly and laterally by the abdominal muscles, anteriorly by the diaghragm, posteriorly it is continuous with the pelvic cavity. It contains the stomach, intestines and kidneys with their accessories. It is lined by the peritoneum, which is reflected over the viscera.

The *Stomach* is a dilatation of the alimentary canal, continuous with the œsophagus and small intestine; where the food is converted into chyme by the action of the gastric juice. In the horse it is small compared to the size of the animal, and is situated on the left and anterior part of the abdomen. It is divided by a central constriction into a left or cardiac, and a right or pyloric portion. It has two openings, one on the left opening into the œsophagus called the cordiac orifice, and one on the right opening into the intestine, called the pyloric orifice. The walls of the stomach are composed of three coats, viz., an external serous, middle muscular and an internal mucous coat. The serous coat is a reflection of the peritoneum. In the muscular coat the fibres are so arranged that their contraction and dilatation produces a churning motion, which macerates the food, and brings each portion of it in contact with the mucous membrane.

The *Mucous Coat* is divided into right and left sections. The latter, called the cuticular portion is continuous with the mucous membrane of the œsophagus, which it resembles. The line between the two portions is well marked. The right portion, called the villous, or true digestive portion, is reddish in color, soft, very vascular and velvety looking. The follicles which secrete the gastric juice are found in this coat.

The *Intestines* form a musculo-membranous tube, and are divided into small and large, the small intestine being continuous with the stomach at its pyloric orifice. These organs are tortuous in their course, and in herbivora āre large and capacious.

The *small Intestine* commences at the pylorus, and terminates in the cæcum. It consists of a convoluted tube, rather more than an inch in diameter, and about 72 feet long. It is divided into the Duodenum, Jejunum and Ileum.

The *Duodenum*, on leaving the pylorus runs forward, then backward, forming an abrupt curve. This is the only fixed portion of the small intestine, is about one foot in length; and fouror five inches from the pylorus is the opening of the ductus communis, a duct common to the liver and pancreas. The *Jejunum* succeeds the duodenum, and includes about two-fifths of the remainder of the small intestine, the *Ileum* constituting the

rest. Both are floating, that is, they are hung in folds of the mesentery. The Ileum terminates in the right and posterior portion of the abdomen. The walls of the small intestine, in common with all hollow viscera of the abdomen, have an external serous, a middle muscular and an internal mucous coat. The mucous coat is soft, reddish and vascular, and covered by villi and follicular openings, and furnished with glands and absorbents. Glands of Brunner, Crypts of Lieberkuhn, Peyers patches and Solitary glands. (The first two secrete fluids which aid digestion, but the latter two are ductless and their function not known.) The absorbents originate in the villi, which are small finger-like valvular processes thickly distributed over the mucous membrane. They consist of loops of the lacteal or chyle vessels, surrounded by a network of capillaries, fine muscular fibres, and small granular corpuscles with a mucous layer covered by epithelium.

In the duodenum the chyme becomes saturated with the bile and pancreatic juice. This is called chylification, or the conversion of chyme into chyle. Chyle is a milky like fluid and is absorbed by the lacteals throughout the remainder of the small intestine.

The *large* intestine extends from the termination of the Ileum to the anus, and consists of 4 parts, viz., the Cæcum, Great Colon, Floating Colon and Rectum.

The *Cæcum*, or blind intestine, is a large Cul-de-sac, commencing at the termination of the Ileum, and passing downwards and forwards towards the sternum, and terminating in a pointed, blind extremity. It measures about 36 inches, and has an average capacity of six gallons. The superior extremity is called the base or arch, and presents a convex curvature directed backwards, and a concave one directed forwards. In the concave curvature the ileum terminates and the colon originates. The opening in which the ileum terminates is situated inferiorly and is guarded by the ileo-cæcal valve, a double fold of mucous membrane. In the mucous coat we have neither Brunner's glands nor Peyer's patches. The follicles of Lieberkuhn, solitary glands and a few scattered villi are, however, present.

The *Great Colon* originates from the cæcum, and terminates near its origin in an abrupt contraction, whence arises the floating colon. Leaving the arch of

the cæcum the large colon passes downwards and forwards to the posterior surface of the diaphragm, where it turns to the left and passes upwards and backwards, and terminates near its origin. It is a voluminous tube with successive dilated and constricted portions, is about nine to eleven feet in length, with a capacity of about eighteen gallons.

The *Floating Colon* succeeds the great colon, and is convoluted like the small intestine, but is twice as large, is about ten feet in length. It chiefly occupies the left flank, and at the anterior part of the pelvis it terminates in the rectum. It is supplied with regular transverse folds and longitudinal bands, the action of which form what are called dungballs.

The *Rectum*, or straight intestine, extends in a straight line from the entrance of the pelvic cavity to the anus, and resembles in structure the floating colon, but has thicker and more dilatable walls. It is related superiorly with the sacrum; inferiorly with the bladder in the horse, and with the vagina and uterus in the mare.

The *Anus* is the posterior opening of the alimentary canal. It forms a round protection which becomes less prominent with age. It is composed principally of muscular tissue.

Accessory Organs of Digestion.

In the abdominal cavity these organs are the Liver, the Pancreas, and the Spleen.

The *Liver* is a solid gland situated in the abdomen, behind and to the right of the diaphragm. It is the largest secreting gland in the body, weighing from ten to twelve pounds, is thick in the centre gradually thinning towards the border, and presenting numerous clefts. It has two surfaces and a circumference. The anterior surface is smooth and convex and cleft by a deep fissure, in which lies the posterior vena cava. The posterior surface is smooth and convex and marked superiorly by a large transverse fissure by which the vena porta enters, and the hepatic canals leave the liver. The circumference may be divided into a superior left and an inferior right. The inferior is cleft by two fissures which divide the organ into three lobes. It is held in position by six ligaments. The coverings

of the liver are an external serous and an internal fibrous coat. The serous is a reflection of the peritoneum. The inner coat consists of a thin fibrous membrane adherent to the glandular substance. It is called Glisson's capsule. It covers the entire gland, and penetrates the organ, forming sheathes for the vessels, and separating the hepatic lobules. The liver consists of minute lobules separated from each other by reflections of Glisson's capsule. Each lobule consists of numerous cells, bilary ductlets and vessels. The cells are arranged in rows radiating from the centre of the lobule. The liver is supplied with nutritive blood by the hepatic artery, and with functional blood by the portal vein, both kinds of blood being returned by the hepatic veins. The hepatic duct leaves the liver at the transverse fissure, and is called the ductus choledochus, and is formed by the union of the branches of the hepatic ducts, This duct joins that of the pancreas at the duodenum, about five inches from the pylorus, and is called the ductus communis. The blood of the portal vein, returning chiefly from the intestines, is charged with bile, which it is the principal function of the liver to remove. This is achieved by the vital power of the hepatic cells. Bile is a greenish colored viscid fluid, with a bitter taste, and an alkaline reaction, believed to stimulate peristaltic action, and the secretion of the glands in the mucous membrane. In solipedes the secretion of bile, although more active during digestion, is constant, there being no resorvoir, or gall bladder for it. Most animals are supplied with a gall bladder, in which the bile accumulates, and passes into the intestinal canal when digestion commences.

The *Pancreas* resembles the salivary glands in strncture and physical properties, but is looser and softer and of a reddish cream color. It is situated behind the stomach and liver, and in front of the kidneys. An oblique opening, "the ring of the pancreas," passes from the inferior to the superior surface, through which the portal vein runs in its passage to the liver. The duct of this gland, "the duct of Wirsung," joins the hepatic duct to form the ductus communis. The pancreatic secretion is clear and colorless. It mixes with the chyme and assists in chylification by emulsify-

ing the fatty materials, and rendering the latter fit for absorption.

The *Spleen* is a soft, reddish organ, situated on the left side of the great curvature of the stomach. It is an exceedingly vascular, ductless gland, having no excretory canals. In the horse it is somewhat scythe shaped, the apex being directed downwards and forwards. It is elastic and distensible, and consists of a serous and fibrous coat enclosing the tissue proper to it, or "parenchyma." The serous coat is a reflection of the peritoneum. The fibrous coat or proper capsule, covers the organ and sends processes into it, forming a network in which is contained the splenic bulb, a red looking material resembling clotted blood. Some of the arteries of this organ terminate in the interlobular space, whence veins arise. Embedded in the spleen pulp are numerous white bodies, "called Malpighian corpuscles" which are attached to the smailer arteries. The function of the spleen is not well understood. It is regarded by some to be an internal refuge for blood when cold is applied to the superficies of the body. Some maintain that it forms blood corpuscles, and others that it is the agent of their destruction, and again others that they are both formed and destroyed in it.

The *Peritoneum*. The abdomen and part of the pelvis are lined by peritoneum. Like all serous membranes, it has a parietal and visceral portion, which together form a complete sac, with the organs it covers situated on its outer side. The internal surface is smooth, free, moist, and secretes a serous lubricating fluid. The external or attached surface adheres to the walls of the abdomen and pelvis, and to the outer surface of the viscera, the former being the parietal and the latter the visceral portion. In order to suspend the different organs it is formed into ligaments, mesenteries and omenta. Ligaments consist of two folds strengthened by fibro-elastic tissue. A mesentery is a double fold of peritoneum attached to the abdominal walls above, and containing a portion of intestine in its free extremity. An omentum is a double fold passing from one abdominal organ to another.

Physiology of Digestion.

Digestion is that process by which the food is prepared for absorption and assimilation.

Hunger is the general want of nourishment in the system. The introduction of food alone into the stomach will not allay the sensation. It must enter into the circulation. The sensation is thought to be due to a congested condition of the capillaries beneath the mucous-membrane.

Thirst is the general want of fluids in the system referred to the throat, may be allayed by introducing fluids into the stomach or injecting it into the veins, or immersing the body in a bath.

Prehension, etc., have been described.

Chymification is effected in the stomach. In the mucous membrane of the stomach we have numerous mucous and peptic follicles, the former secrete mucous and the latter gastric juice. This membrane is abundantly supplied with blood vessels. The nerves are derived from the pneumogastric and sympathetic nerves.

Gastric juice is a clear, colorless fluid of an acid reaction, secreted only during digestion or as a result of irritation. The quantity of gastric juice secreted during 24 hours is large, 10 to 12 pints, it is in part reabsorbed. The secretion is much influenced by nervous conditions. Is diminished by temper, fear, joy, fatigue, mental exertion, or any febrile disturbance of the system.

Chemical composition of human in 1000 parts.

Water	994.40
Pepsine	3.19
Hydrochloric Acid	.22
Salts	2.19

Gastric juice is acid. It has a liquifying action on the food by catalysis. It acts on the nitrogenous portions of the food, and saccharine matter is rendered fit for absorption in the stomach, while the starchy matter and fat pass into the bowels before being changed.

Chylification takes place in the small intestine, but principally in the duodenum. The starch and fat pass unchanged into the small intestine where they come in contact with the mixed intestinal juices, and are re-

duced to a state fit for absorption. These juices are the secretions of Brunner's glands, the follicles of Lieberkuhn, the pancreatic juice and bile. These juices have an alkaline reaction. The secretion of Brunner's glands and the follicles of Lieberkuhn act on the starch, converting it into sugar, rendering it fit for absorption.

The pancreatic juice also acts on the starch, as well as assisting in the digestion of fat. It further assists in the complete digestion of nitrogenous matters that have escaped the gastric juice.

Bile is a thick, viscid fluid, of a greenish color, a bitter taste, and nauseous smell. It aids in the digestion of fat. It also contains substances removed from the blood by the liver, which, if allowed to remain, would be poisonous. It is the natural purgative of the body. It also prevents decomposition of fæcal matters.

The function of the large intestine is mainly confined to the separation and discharge of the fæces. The ileo-cæcal valve prevents a reflux of the contents of the large intestines. The surface of it towards ileum is covered by villi, while the rest is almost destitute. Fluids are absorbed in the large intestine, so that the longer the fæces remain there the dryer they become. Nutritive fluids can be absorbed. The fæces are urged on by the vermicular action of the intestine to the rectum, where they accumulate, and are prevented from escaping by the contraction of the anus. The accumulated matter causes a sensation demanding its discharge, which is effected by the contraction of the abdominal muscles, diaphragm and rectum, overcoming the musclar fibres of the anus.

The *Spleen* is thought to be a storehouse for nutritious material which may be drawn on as the system requires, also an agent in forming colorless corpuscles of the blood.

Respiratory System.

By the actions of these organs certain chemical and physical changes take place in the blood. The chief of these consisting in the absorption of oxygen from, and giving off carbonic acid to, the atmospheric air; the former being necessary for the elaboration of the fluid, the latter for the elimination of a substance which,

if retained, would prove prejudicial. Respiration is carried on in the mammalia by means of elastic air receptacles called lungs, which are enclosed in special cavities, and communicate with the atmospheric air by means of an air tube. In the horse, who breathes only through the nostrils, the organs of respiration are the Nostrils, Nasal Chambers, Pharynx, Larynx, Trachea, and in the thoracic cavity the Bronchi, Bronchial tubes, and Lungs.

The *Nostrils* are situated at the anterior extremity of the nasal chambers, and are right and left. They consist of an incomplete cartilaginous skeleton covered by muscles, and lined internally by mucous membrane. They are bounded by movable wings or alæ. The commissures of the alæ are a superior and an inferior. The superior is the false nostril, the finger introduced into which, enters a cul-de-sac. The inferior commissure is large and round, and has, at a short distance within, an opening, sometimes double, which is the inferior opening of the lachrymal duct. The nostrils have the power of dilating and contracting considerably, their use being to give passage to the air during inspiration and expiration.

The *Nasal Chambers* are cavities extending from the ethmoid bone to the nostrils, and are separated from each other by the septum nasi, which forms the internal wall, the external is formed by the superior maxilla. Each chamber is divided into three passages, a superior, middle and inferior. There are two turbinated bones in each chamber, the inferior and superior. They are formed of very delicate convolutions of bones void of periosteum; their use is to augment the surface of the nasal chambers over which the olfactory nerve is distributed, while by their lightness they add very little to their weight. The nasal chambers are lined by a very delicate, pale, rose colored mucous membrane, called the pituitary, or schneiderian membrane; it is very delicate and contains the special sense of smell.

The *Pharynx* is common to both digestive and respiratory systems, and has been described.

The *Larynx* is a complete musculo-cartilaginous valve, situated at the anterior extremity of the windpipe. It gives passage to the air, and is the organ of voice. The anterior extremity opens into the pharynx,

and the posterior is continuous with the trachea. It is composed of 7 cartilages, 3 singles and 2 pairs. The former are the Cricoid, Thyroid and Epiglottis, and the latter the Ayrtenoid and Cuneiform.

The *Cricoid* , or ring-like cartilage, is situated at the base of the larynx surrounding the air passages.

The *Thyroid*, or shield-like cartilage, is the largest. It consists of two lateral expansions which unite antero-superiorly at a rather acute angle forming a projection called the body of the Thyroid, which corresponds to the pomum Adami inman.

The *Arytenoid*, or ewer-shaped cartilages, a pair, lie upon the cricoid, and bound supero-posteriorly the entrance of the larynx. They are irregularly pyramidal, and their anterior surface forms a lip or spout, in which rests the epiglottis when the larynx is closed.

The *Epiglottis* is a soft leaf like cartilage, flexible, and situated in front of the opening to the larynx, which it completely closes during the passage of food to the œsophagus. Its anterior surface is attached to the tongue and hyoid bone. From its base two lateral cartilages extend backwards. These are the *cuneiform* cartilages, a pair, and they are situated in the folds of the mucous membrane, which stretch from the epiglottis to the arytenoid cartilages, together forming the false vocal cords.

The true vocal cords are formed by the thyroarytenoidean ligaments covered by mucous membrane, and the narrow passage between them is called the glottis, or Rima glottidis. Between the true and false vocal cords on either side is a deep fossa, the ventricle of the larynx.

The *Trachea*, or wind pipe, a nearly cylindrical, flexible tube, consisting of a series of incomplete cartilaginous rings. It succeeds the larynx, runs down the neck, enters the thorax, and terminates at the base of the heart, where it divides into right and left bronchi. It varies in length, there being from 40 to 50 rings, the ends of which overlap each other superiorly. It presents a number of transverse furrows which correspond to the interspaces between the rings. The extremities of the incomplete rings are joined by ligaments which contain muscular fibres. It is lined by mucous membrane.

The *Thyroid* gland is a brownish red body, situated

about the second or third tracheal ring, consisting of two lobes joined by a narrow band. The gland is ductless and secretes an albuminous fluid. It is large in fœtal life, but its use is unknown.

The *Thymus* is another ductless gland, situated on the inferior aspect of the trachea, and above the sternum. It consists of two lobes united by areolar tissue. In the fœtus it is attached to the thyroid, is large at birth, gradually disappearing.

Bronchi and *Bronchial Tubes*. The terminal branches of the trachea are the right and left bronchi, which enter the lungs and sub-divide into branches, termed bronchial tubes, which re-divide until they become very small, and terminate in the air cells. The entire ramification, when isolated, has the appearance of a tree. The right bronchus is larger than the left. The left is longer, as it passes under the aorta before reaching the lung. The bronchi and bronchial tubes are made up of cartilaginous rings, differing only from the trachea in being made up of several pieces, which overlap and are united by cellular tissue on their inner surface. As the tubes diminish in size, the number of these pieces are diminished, and finally disappear. The air cells consist only of the lining membrane of the tubes.

The *Thorax*, or thoracic cavity, is formed by the ribs, sternum and bodies of the dorsal vertebræ, the intercostal muscles and diaphragm. It contains the lungs, the heart and its adjuncts. the trachea, œsophagus and a quantity of nerves.

The *Pleura*. The thorax is lined by two serous membranes, the right and left pleuræ, which consist of parietal and visceral portions, and form two distinct sacs. Each pleura lines one-half of the thorax and half of the diaphragm, and covers the lung on that side. The portion of pleura lining the ribs is called *pleura costalis*, that covering the diaphragm, *pleura diaphragmatica* and that covering the lung *pleura pulmonalis*. In the mesian longitudinal plane, between the lungs, it forms with the opposite pleura, the *mediastinum*, which is divided into three portions. The anterior portion lies in front of the heart, the middle contains it, while the posterior lies behind it. The mediastina contain the trachea, œsophagus, heart,

vessels and nerves. The pleura is thick and loosely attached over the ribs, attenuated over the diaphragm and pericardium, and extremely so over the lungs. Its inner surface is smooth, and secretes a vapory fluid, which lubricates its surface and facilitates motion.

The *Lungs*, the essential organs of respiration, are spongy organs of a conical shape, situated in the thoracic cavity, right and left, the former being slightly the larger. They are separated by the mediastinum, heart, pericardium and large blood vessels. They are light, porous and highly elastic, possessing considerable strength. Healthy lungs float in water, their buoyancy being due to the air they always contain. The external shape corresponds to the shape of the thoracic cavity. The internal surface, or where the two lungs meet, forms a vertical plane in contact with the mediastinum, and presents an anterior division, which rests against the anterior mediastinum, in front of an excavation in which the heart is lodged. Structurally the lungs consist of an external serous coat, a subserous layer, and the lung tissue proper or *parenchyma*. The serous coat is the pleur pulmonalis The subserous layer is composed of cellular tissue. The parenchyma is divided into many lobules of various sizes, united by connective tissue. These are again made of smaller ones, each of which is composed of a small bronchial tube and its terminal air cell, in the wall of which are the capillaries which unite the pulmonary arteries with the pulmonary veins. The air cells are vesicular cavities, arranged in bunches at the end of the tube; they consist of a thin membrane of connective and elastic tissue with a layer of pavement epithelium.

Physiology of Respiration.

Respiration is for the purpose of removing impurities from the blood, the chief of which is carbonic acid; and the supplying of oxygen to that fluid, thus rendering it fit to nourish the tissues. It consists of two acts, viz., Inspiration and Expiration, the former is due to the chest being enlarged by contraction of the diaphragm and elevation of the ribs by the muscles.

Expiration succeeds inspiration after a brief interval, and is accomplished by the elastic recoil of the lungs

and walls of the chest, also by the contraction of the abdominal muscles.

The temperature of expired air is variable, but under ordinary circumstances is higher than that of inspired air, when the external temperature is low that of expired air sinks somewhat, when the external temperature is very high the expired air may become cooler than the inspired. The expired air contains 4 or 5 per cent. less oxygen, and about 4 per cent. more carbonic acid than inspired air, the quantity of nitrogen suffering but little change. Besides carbonic acid, expired air contains various impurities, many of an unknown nature. Ammonia has been detected in expired air. When the expired air is condensed by passing into a cool receiver the aqueous product is found to contain organic matter and to rapidly putrify. The organic substances present in expired air are the cause in part, of the odor of the breath.

The blood, in passing through the lungs is robbed of a portion of its carbonic acid, and loaded with a certain quantity of oxygen. Respiration is an involuntary act, though all the muscles employed are voluntary; and though respiration may be modified to a limited extent by the will, yet we habitually breathe without the intervention of the will. The normal breathing may continue not only after unconsciousness but even after the removal of all parts of the brain above the medulla oblongata.

Urinary System.

The organs of this system secrete the urine from the blood, and excrete, or expel, it from the body. These organs are the Kidneys, Ureters, Bladder and Urethra. The urine is secreted by the kidneys, carried by the ureters to the bladder, where it accumulates, and from which it is expelled through the urethra.

The *Kidneys* are two compound tubular glands, situated on the right and left of the vertebral column in the sublumbar region of the abdomen. They are supported by peritoneum and cellular tissue, by their vessels, and by the pressure of the intestines. The right one is in advance of the left, lying just behind the last pair of ribs, while the left is about two inches further back, and is longer and narrower than the right. In

shape they somewhat resemble the heart on playing cards. The suprarenal capsule is attached to the anterior border. The internal border of the kidney is slightly concave and deeply notched in its centre, forming the *hilus* which leads to the cavity called the *sinus*. The vessels, nerves, and duct of the kidney join it in, or about, the hilus. The kidney is made up chiefly of the tubes of the gland, *uriniferous tubes*, with blood vessels, nerves and connective tissue. It is invested with a fibrous capsule and contains a cavity called the *pelvis* of the kidney. This capsule invests the entire organ, entering the hilus and covering the sinus, vessels and duct. On making a horizontal section of a kidney we find it to consist of an external or *cortical*, and an internal or *madullary* substance. The cortical portion is a dark reddish brown and friable, consisting of minute blood vessels, convolutions of uriniferous tubes, lymphatics and nerves, united by areolar tissue. On examining a section with a lens red points are seen, called the *Malpighian bodies*. Each consists of capillary blood vessels, arranged in a tuft, surrounded by epithelium, and enclosed in a capsule, the capsule of Bowman, which is the dilated organ of a uriniferous tube. The small branch of the renal artery entering the capsule is the *afferent vessel*, whence proceed the capillaries which form the tuft. The *efferent vessel* leaves the tuft near the afferent one, forming a plexus round the adjacent tubes, terminating in veins.

A dark line separates the cotticle from the madullary portion, which is denser in structure, fibrous in appearance, and consists of pale conical masses, the *pyramids of Malpighi*. These are composed of minute, diverging uriniferous tubes. In the horse they terminate in a continuous ridge, which project into the pelvis, and on these ridges are the *outlets*. Through these outlets the urine passes into the pelvis, a cavity in the centre of the kidney formed by the dilatation of the ureter, which has lateral prolongations called the arms. The function of the kidneys is to secrete the urine, a fluid consisting of water, holding in solution a varying quantity of earthy salts, and a peculiar nitrogenous substance, *urea*, which, if not eliminated, acts as a blood poison.

The *Suprarenal Capsules* are two small, flat, reddish brown bodies, attached to the anterior border of

the kidneys. They are ductless and their function is unknown.

The *Ureters* are two canals which convey the urine from the pelvis of the kidney to the bladder. On leaving the hilus they are directed towards the pelvic cavity, terminating in the upper and back portion of the bladder which they enter on either side by piercing its coats in an oblique manner, which prevents regurgitation of the urine.

The *Bladder* is a musculo membranous organ, serving as a reservoir for the urine, situated in the pelvic cavity, and when full projects into the abdomen. It consists of a fundus or body, and a neck. The *fundus* when full is ovid, and turned forward, having a cicatrix, which marks the site of the *urachus*. The *neck* is turned backwards and is continuous with the urethra. It is related above with the rectum in the male, and with the vagina and uterus in the female. The bladder consists of 3 coats, mucous internal, muscular in the middle, and serous external. The contraction of the walls forces the urine into the urethra.

The *Urethra* is a tube, common, in the male, to the urinary and genital organs, and will be described with the latter.

Generative System.

Animals possess the faculty of reproducing or propagating their species. This function may be sexual or non-sexual, the latter being confined to lowly organized classes of animals. In all the higher animals the generation of a new being depends on two individuals, a male and a female, the female furnishing a germ of ovum, and the male a fluid or sperm, which animates the germ and renders it fit for development. Both the ovum of the female and the sperm of the male are the secretion of glands, called genital glands, and in either sex the generative system may be said to consist or these glands, with certain accessory organs. The act of coition bring the secretions in contact.

Male Genital Organs.

The spermatic, or seminal fluid of the male is elaborated in two glands, situated in the scrotum, called the

testicles, each being furnished with an excretory duct, the Vas deferens, which transmits the sperm to the reservoirs, the Vesiculæ Seminales, situated on the bladder. Here the sperm accumulates, and is expelled by the contractile walls of the vesiculæ during the act of copulation, through the ejaculatory ducts into the urethra, which is common to the urinary and genital organs. The urethra is provided with accessories, the prostrate and Cowper's glands, and is supported by an erectile tissue which forms an elongated organ, the penis.

The *Scrotum* is a sac, or bag, which contains the testicles, situated between the thighs, and made up externally of a layer of skin. It is marked in the middle by a longitudinal raphe, indicating its division into right and left cavities. Below the skin is a thin layer of muscular and elastic tissue, forming a tunic called the *dartos*, which sends in a fold between the testes called the *septum scroti*.

The *Inguinal Canals* are slit like apertures in the posterior part of the floor of the abdomen, through which passes the spermatic cord in the male, and the mammary vessels in the female. The external orifice is called the *external inguinal ring*, and the internal orifice the *internal inguinal ring*, and the space between the *inguinal canal*.

The *Spermatic* cord suspends the testicle in the scrotum (one to each testicle). It is made up of the Vas deferens, blood vessels, nerves and serous membrane, muscular tissue and fascia. It extends from the inguinal canal to the testicles, certain coverings being common to it and the latter.

The *Testicles* are two oval glands, situated in the scrotum, attached superiorly to the spermatic cord. In fœtal life they are at first situated behind the kidney, and above the peritoneum. At a certain period they descend through the inguinal canals into the scrotum. In their descent each is guided by a soft cord, the *gubernaculum testes*. In their descent they carry with them coverings derived from the abdominal parieties, also coverings composed of peritoneum. The first tunic proper to the testicle is the *tunica albuginea*, which is reflected into its substance, forming a septum called the *mediastinum testes*, from which processes

are sent out dividing the testicle into lobes. Inside of this tunic we have the *tunica vasculosa* enclosing the testicle and giving off vascular processes to it. The testicle is divided into from 200 to 300 distinct lobes, which consist of numerous tubes with cæcal ends, called *tubuli seminiferi* in which the semen, or sperm, is secreted.

The *Epididymis* is an elongated body extending along the upper border of the testicle. It consists of a body, a head, and a tail. The body is free and curved to the shape of the testicle. The head, situated anteriorly, is adherent to the testicle. It is the largest part and gradually becomes slimmer towards the body. The epididymis is composed of small convoluted tubes, which join and become larger until they form one single tube, the vas deferens.

The *Vas Deferens* is a tube with solid walls, which, after leaving the epididymis, ascends the back part of the spermatic cord to the inguinal canal, where it leaves the cord, enters the pelvis, and passes to the neck of the bladder, where it is joined by the duct of the vesicula seminales, the two forming the ejaculatory duct.

The *Vesiculæ Seminales* are two pear-shaped, glandular pouches, situated on each side of the postero-superior aspect of the bladder, and between it and the rectum. They are receptacles for the semen, and secrete a special fluid which mixes with the semen.

The *ejaculatory ducts* are right and left, formed by the junction of the vas deferentia and the vesiculæ seminales. They terminate in the urethra by two orifices.

The *Uterus Masculinus* represents in the male, the uterus in the female. It is a canal about four inches long, which ascends in the folds of the peritoneum between the vas deferentia. Its lower end is situated between the ejaculatory ducts.

The *Prostrate gland* is situated around the neck of the bladder and commencement of the urethra. It varies in size, and consists of three lobes, a middle and two lateral. The middle one lies on the neck of the bladder, and in old age sometimes becomes enlarged, and presses on the urethra, causing retention of urine. The secretion is excreted by ducts into the urethra.

Cowpers glands are a pair of small bodies, situated on either side of the membranous portion of the urethra, above the ischial arch. They resemble the prostrate gland in structure, and terminate in the urethra by a row of minute openings on either side.

The *Urethra* is a tube which extends from the neck of the bladder to the glans penis in the male, and to the vulva in the female. In the latter it is merely an excretory passage for the urine, but in the male it also transmits the seminal fluid.

The *penis* is the male organ of copulation. It contains the greater portion of the urethra. It may be said to consist of an attached and a free portion, the first originating at the ischial arch, and terminating before the brim of the pubis, where the free portion commences. The penis is formed of what is called *erectile tissue*, which, under certain circumstances, becomes enormously distended with blood. The erectile structures are two in number, the *corpus cavernosum* and the *corpus spongiosum*. The corpus cavernosum is much the larger, and forms the superior and lateral portions of the penis. This portion is invested by a strong, elastic, fibrous tissue, which sends out processes dividing the structure into numerous compartments which receive the blood during erection of the organ. The corpus spongiosum encloses the urethra, and is situated in a groove in the inferior portion of the corpus cavernosum. At the anterior extremity it expands to form the *glans*. At the apex of the glans is a deep fossa, in the centre of which lies the *meatus urinarius*.

The *Sheath* is a loose fold of integument, which invests the free portion of the penis. It forms a sac extending from the scrotum forward. Anteriorly a loose fold of the sheath projects, covering the anterior extremity of the penis when quiescent; this is the *prepuce* or foreskin, and from it the skin contines in a modified form over the glans, while it covers and becomes continuous with the mucous membrane of the urethra. The corrugations of the prepuce admit of the erection and protrusion of the penis. Opening on its inner surface are the *glandulæ odoriferæ*, which secrete a peculiar odorous matter.

The *Seminal fluid*. The secretion of the male genital organs is a viscid, whitish albuminous fluid the sperm or seminal fluid, which contains the *spermatozoa*, microscopic objects consisting each of an ovid head and a long wavy tail. They possess a certain vibratory motion, and have the power of penetrating and fertilising the female ovum.

The *female genital organs* are the *ovaries* which furnish the *ovum* or germ of the future animal. The ovum is conveyed along the *Fallopian tube* to the *uterus*, a cavity in which it becomes impregnated by the sperm of the male, and developed. The vagina is a tube or cavity analogous to the urethra in the male, common to the urinary and genital systems, the uterus opening into it anteriorly and the meatus urinarius being situated at its posterior boundary.

The *Ovaries*, being the analogues of the testicles, are the ultimate organs of generation in the female. They are similar in shape, but smaller than the testicles, and are situated in the sublumbar region of the abdomen, a little behind the kidneys, their tunic resembling that of the testicles, is a dense *tunica albuginea*. Within are numerous small bodies, called the *Graafian vesicles*, which contain a fluid in which the true ovum resides. This fluid is secreted by the cells of this vesicle. It increases in quantity as the vesicle developes. During the period of heat or *œstrum* the walls burst, and the fluid with the ovum escapes into the Fallopian tube and is carried to the uterus. The ovum is, in the higher animals, microscopic, being about 1-150 of an inch in diameter.

The *Fallopian Tubes* are two canals which convey the ovum from the ovaries to the uterus. They run in a serpentine route from each uterine horn to the ovary. Each commences in a very minute opening, the *ostium uterinum*, and terminates in a small orifice, the *ostium abdominale*, which communicates with the abdomen. The free extremity of the tube terminates in a series of fringes which are arranged in a circle around the ostium abdominale. One of these fringes is attached to the ovary and along it is a fissure, continuous with the external opening of the tube. The fringes embrace the ovary during sexual excitement, receiving the ovum on rupture of the vesicle and conveying it to the fallopian tube.

The *Uterus*, or womb, is a musculo membranous sac situated in the sublumbar region and pelvic cavity. It consists of a *body* and two *horns*. The body is cylindrical and somewhat flat. Its superior surface contacts the rectum, which passes between the horns. The anterior extremity is continuous with the horns, and the posterior with the vagina, constituting the *neck*, which is thick and round, and projects into the vagina in the virgin animal; in its centre is a canal, the *os uteri*, leading into the body. The horns spring from the anterior extremity of the body, diverge upwards and forwards, communicating with the Fallopian tube. The uterus consists of three coats, an external serous, middle muscular and an internal mucous. The serous coat is a reflection of the peritoneum, it forms the broad ligament which suspends the uterus.

The *Vagina* is a canal leading from the uterus to the vulva. It is wide and surrounds the neck of the uterus, but is constricted at the vulva. It is the chief female organ of coition.

The *Vulva* is the external orifice of the urino-genitial system, is situated below the anus, appears as a long ovid slit, presenting two lips and two commissures. The lips have an external covering of soft skin, and an inner one of mucous membrane. Between these is a quantity of fat and areolar tissue, and some erectile tissue. This structure is charged with blood during copulation, rendering co-aptation very complete. In a depression on the floor lies the *clitoris*, which is composed of erectile tissue and becomes erect during copulation. The external orifice of the urethra, the meatus urinaries, open on the inferior surface of the vulva, about four inches from the external opening. It is larger than the male opening, and is surrounded by a fold of mucous membrane, which acts as a valve.

The *Hymen* is a thin semi lunar fold of mucous membrane, which imperfectly separates the vulva from the vagina, lying immediately before the meatus. It is ruptured during the first act of copulation.

From the above descriptions it will be apparent that in the male animals the female organs are indicated, as are the male organs in the female. Thus in the male the uterus masculinis represents an undeveloped uterus, and in the female the clitoris, a rudimentary penis.

This points to the fact that in early fœtal life there is no distinction of sex. each animal having rudimentary male and female generative organs. Should both systems of organs in the same animal become more or less developed, but neither of them perfectly so, the animal is said to be *hermaphrodite*.

The *Mammary Glands* in the young female, as in the male, are rudimentary, becoming developed in the former at puberty, or when the animal is fit for reproduction. In the mare these glands are two in number. In full activity they present 2 hemispherical masses, separated by a shallow fissure, each half presenting in its centre a nipple, or *teat*, pierced at its free extremity by numerous orifices for the passage of milk. The interior of the gland is made up of yellow glandular tissue, consisting of numerous lobes united by a cellular tissue; each of these is again made up of small lobules composed of minute ducts and numerous small cells, in which the milk is secreted, and conveyed to the ducts, which unite to form a common excretory duct for each lobe. These ducts converge to the centre of the gland where they terminate in dilated cavities, the *lactiferous sinuses* which communicate with each other. From these proceed a number of canals which run to the free extremity of the teat by constricted orifices. The mucous membrane of the teat is surrounded by muscular fibre, which acts involuntarily as a sphincter, and retains the milk. The base of the teat is surrounded by certain glands secreting a lubricating fluid which protects the teat during the sucking of the young, and prevents the plugging of the orifices by coagulation of the milk.

Comparative Anatomy.

We will now briefly consider the four systems we have been studying, and note the principal differences between the anatomy of the horse and ruminants.

The lips of the ox are thick and only indirectly prehensible. The centre of the upper lip is devoid of hair and constitutes the muzzle, and in health is always moist. The lips of smaller animals are thin, very mobile, and are agents of prehension. The cheeks of ruminants present on their inner surface conical papillæ which point backwards. The soft palate is not

so complete and pendulous as in the borse, thus permitting the animal to breathe through the month and allowing the upward passage of food. The tongue of the ox is prehensible, and is rougher, shorter and thicker than in the horse, and pointed at the tip. The ox and sheep have no incisor teeth in the upper jaw, but instead have a thick cartilagenous pad with which the lower incisors come in contact in cropping grass, etc. The incisors are eight in number in the lower jaw, and have a certain degree of mobility which prevents injury to the pad. The œsophagus is well developed, and its muscular walls are red throughout, and joins the stomach by expanding. The muscular fibres induce both a downwards, or a peristaltic and an upwards, or anti-peristaltic, motion.

The *Stomach* of ruminants is a very complex organ, consisting of four compartments, which vary in size and form, and in the disposition of their mucous coat. The first is the *rumen*, or paunch, the second the *reticulum*, or honey comb, the third the *omasum* or many plies, and the fourth the *abomasum* or true digestive stomach. The first three are principally concerned in preparing the food for the fourth, and have little to do with the essential process of digestion. The *rumen* is very large, occupying about three-quarters of the abdomen. It is situated on the left side. The surface is smooth and divided into two lateral regions by a groove. The anterior extremity receives the insertion of the œsophagus, and is continuous with the second compartment, and is bounded anteriorly by the second and third, and the diaphragm. The posterior occupies the entrance of the pelvic cavity, where it contacts the urino-genital organs. In the female the uterus is prolonged over its surface. The superior surface is related with the intestines, while the inferior rests upon the floor of the abdomen. The left side, to which the spleen is attached, is in contact with the abdominal walls in the lumbar region. The interior is incompletely divided into four sacs by fleshy pillars. The mucous coat is cuticular, papillated, and covered by thick epithelium. The *reticulum* is the smallest of the four, and is situated between the diaphragm and the rumen. The internal surface is divided into polyhedral cells by folds of mucous membrane. It communicates

with the rumen, the œsophagus and the omasum. The communication with the latter two is by the œsophageal canal, a continuation of the œsophagus, which commences at the cardiac orifice, passes along the roof of the reticulum and enters the omasum by a circular opening. Its sides consist of two movable lips, which are continuous with the muscular walls of the œsophagus, and are attached by one border to the superior wall of the reticulum, the other being free. There are transverse and longitudinal fibres in the muscular coat of this canal. The longitudinal fibres by contracting draw the lips together, forming a channel leading from the œsophagus to the omasum, thus effectively closing the opening into the rumen and reticulum.

The *Omasum* is also situated between the diaphragm and the rumen, and when full is ovid. The left extremity is constricted, forming the neck, by which it communicates with the reticulum. The interior is filled with leaves, or folds of mucous membrane, which follow the long axis of the organ. Between each pair of large we have small leaves, which extend a limited distance only. They consist of an inner framework of muscular fibres, clothed with mucous membrane, studded with papillæ, some of which are small, others large and bent, the latter retaining crude portions of food for further trituration and maceration, while fluids and finer portions pass directly to the abomasum.

The *Abomasum*, or true digestive stomach, is continuous with the omasum and duodenum, from the latter it is separated by the pyloric ring. The interior resembles the villous portion of the stomach of the horse, having glands and follicles which secrete gastric juice.

The process of rumination is believed to be effected as follows: The food being swallowed falls into the rumen, where it is tossed about by the muscular action and saturated with fluid, a portion is thrown through the valvular opening into the reticulum, and gains a further supply of fluid, and the finer particles are separated from the coarser, the former proceed to the omasum, the latter, by the muscular contraction of the reticulum, the relaxation of the œsophageal pillars and the anti-peristaltic action of the œsophageal walls, is returned to the mouth to be remasticated, and once more swallowed. Any coarse portion again falls into

the rumen to be reacted on, the remainder passes down the œsophageal canal to the omasum, whence liquids flow into the abomasum, while solids are drawn between the leaves of the omasum to be further prepared.

The *small intestine* differs little from that of the horse, except that it is smaller in calibre but on an average twice the length. There is no distinct separation between the great and floating colon as in the horse. The total length of the large intestine in the ox from the cæcum to the rectum is 36 feet, but its capacity is much less than that of the horse.

The *Liver* of the ox is very thick, and is provided with a pear-shaped gall bladder lying upon its posterior surface. The duct of the gall bladder enters the duodenum singly, not connecting with that of the pancreas, as in the horse.

Respiratory System.

There are not many important differences. We may note the presence of a third bronchus which passes to the right lung to supply a lobe which is wanted in the horse. The left lung is divided into 2 lobes, the right into 4. The interlobular cellular tissue is exceedingly thick, the separation between the lobules being distinctly visible.

The Urinary System.

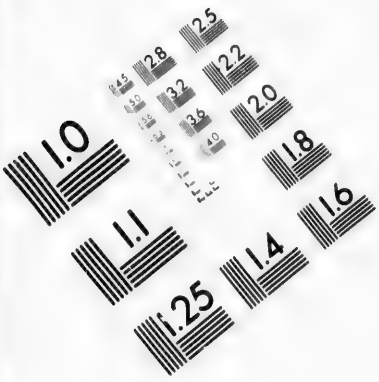
The kidney of the ox is more or less lobulated somewhat resembling a bunch of grapes.

The Genital System.

Male Organs.

The testicle is ovid and well developed, the vasa deferentia join and form one common duct. The urethra gradually diminishes in calibre from its origin, its most prominent feature is, that just before the pubis it describes a double curve on itself something like the letter "S." The prostrate gland is small. Cowper's glands are wanting.

The *Penis* is long and thin and projects far under the abdomen, like the urethra it is bent upon itself forming the letter S which becomes straight when erected. The sheath extends much further forward than in the horse.



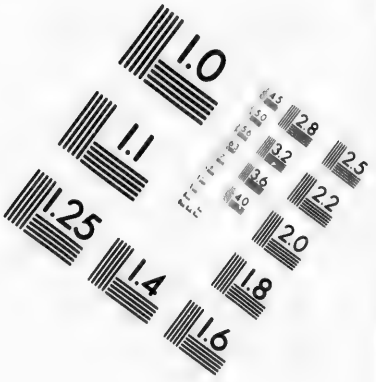
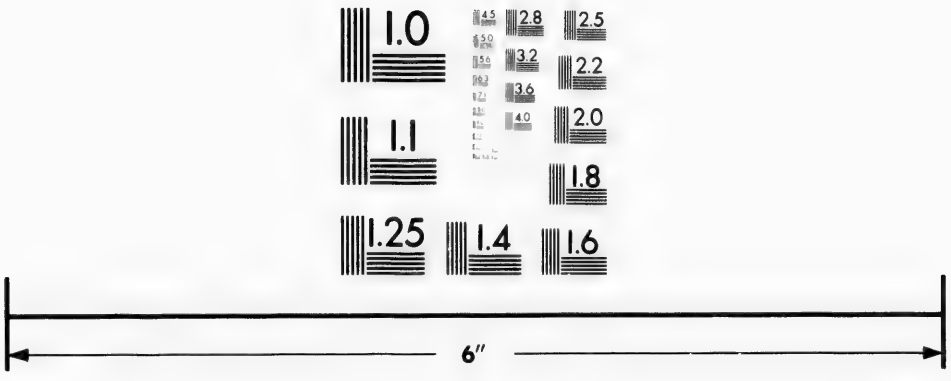
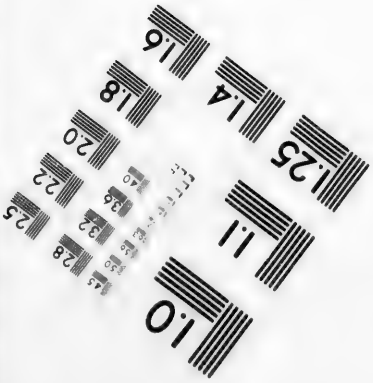
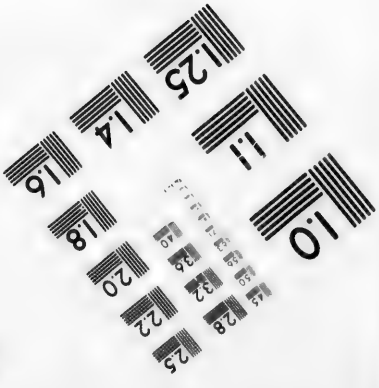


IMAGE EVALUATION TEST TARGET (MT-3)







Photographic Sciences Corporation

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

Female Organs.

In the female the ovaries are comparatively small. The uterus presents generally the typical arrangement, but the mucous membrane presents a number of rounded vascular processes which exhibit eminences and depressions, these are termed *maternal cotyledons* and their function is a fœtal one. The mammary glands in the cow constitute an organ called the udder, which is composed of two symmetrical halves placed one against the other. Each half is again divided into 2 distinct glands, each with its own teat, so that the udder consists of 4 mammæ and 4 teats; behind these there may be two rudimentary teats. There is but one excretory channel in each teat.

In the small ruminants there are 2 mammæ and 2 teats constructed like those of the cow.

Angiology.

Under this head we describe the organs of circulation, by the action of which certain fluids are propelled through the body. We will divide it into two sections, the Blood-Vascular and Lymphatic system.

The Blood-Vascular System.

This involves the Blood, Heart, Arteries, Veins and Capillaries.

The *Blood* is a fluid which nourishes all living structures, being the medium by which nutritive material is conveyed to, and effete material conveyed from the solid tissues. Its color varies in different parts of the same animal, that in the arteries being bright red or scarlet, while that in the veins is of a dark purplish hue. Microscopically examined it is found to consist of minute corpuscles, and a clear, yellow fluid, "the *liquor sanguinis*," in which the corpuscles float. The corpuscles are of two kinds, the red and the white, the former are much more numerous and vary in shape. In mammals they are more or less discoid and bi concave, their average diameter being one-four-thousandth part of an inch, and thickness one-quarter of this. The *white corpuscles* are larger, round and nucleated. The *liquor sanguinis* is pale and clear and consists of water, fibrin, albumin, fatty compounds, oderiferous and

saline matters. The *serum* consists of liqnor sanguinis deprived of fibrin. It contains 90 per cent. of water and coagulates when heated, owing to albumin. Fibrin is a white, stringy, elastic substance which is in solution in circulating blood and cannot be distinguished from other constituents of liquor sanguinis.

The *Heart* is a hollow, involuntary, muscular organ, situated between the layers of the middle mediastinum, and in the pericardial sac. Its form is that of a blunt cone slightly flattened from side to side, and it presents a base and an apex. The base is turned upwards and towards the dorsal vertebræ, from which the heart is suspended by the blood vessels. The apex points downwards, backwards, and to the left side, lying at about the level of the last bone of the sternum. The organ extends from about the third to the sixth rib inclusive. The average weight of a horse's heart is about six and a half pounds, its length about eight inches, its antero posterior diameter rather less, its lateral diameter less still The heart is divided by a longitudinal septum into a right and left side. Each of these is again subdivided by a transverse septum into two compartments which communicate. Thus there are four cardiac cavities, the superior ones, whose free extremities somewhat resemble a dog's ears, are called the *auricles*, the inferior ones, the *ventricles*. These divisions are marked externally by deep grooves, in which the cardiac blood vessels run and which are usually filled with fat. Two of these grooves extend from the base of the ventricles to the apex, and are called the anterior and posterior longitudinal furrows. Around the base of the ventricles is a deep transverse auriculo-ventricular furrow which marks the division of the heart into an upper or auricular and a lower or ventricular portion. The right side of the heart is sometimes called the *venous* and the left the *arterial* side. We will first consider the cavities of the right and then those of the left.

The *Right Auricle* is the larger and forms the right and anterior portion of the base. It presents 2 cavities, the *sinus venosus* and *auricular appendix*. The former, the principal cavity, has thin walls and is connected inferiorly with the right ventricle, internally with the left auricle, and prolonged anteriorly to form the

appendix, a small conical pouch with thick wall and serrated edges. On laying open the auricle we notice the smooth, transparent Endocardium, or lining membrane, the anterior and posterior Vena-cavæ, Coronary sinus, Foramina Thebesii and the right Auricular Ventricular opening. The anterior Vena-cava opens into the supero-posterior part of the sinus venosus. The posterior Vena-cava opens into the infero-posterior part of the external wall of the sinus. The Coronary sinus is below the opening of the posterior Vena-cava; through it the blood is returned from the substance of the heart, the coronary valve covers the opening. The Foramina Thebesii are minute openings on the inner surface of the auricle, being the openings of small veins which return the blood directly from the walls of the heart. The right Auriculo-ventricular opening is large and oval, occupying the floor of the auricle and communicating with the right ventricle. On the Auricular septum is a depression, the *fossa ovalis*, the remains of the foramen ovale. There are columns of muscular fibres chiefly in the appendix called *musculi pectinati*, from their resemblance to the teeth of a comb.

The *Right Ventricle* occupies the antero-inferior part of the right side of the heart. Its walls are thicker than those of the auricle but thinner than those of the left ventricle. On laying the cavity open two openings are seen. The *auriculo-ventricular* communicating with the auricle, is surrounded by the auriculo-ventricular ring, and guarded by the tricuspid valve, which is formed by a doubling of the lining membrane, strengthened by fibrous tissue. It consists of 3 triangular segments, which, connected at their bases, surround the opening. The edges are thick, and to their ventricular surfaces are attached a number of tendinous cords, the *chordæ tendineæ*, which spring from the *musculi-papillaries* and the inner surface of the ventricle. The valve prevents regurgitation of blood into the auricle when the ventricle contracts. The second opening is the origin of the *pulmonary artery*. It is above and to the left of the auriculo-ventricular opening, and is guarded by three *semi-lunar* or *segmoid* valves, which consist of folds of lining membrane, and are attached by their convex margins to the tendinous ring which surrounds the opening. Their free edges are nearly

straight and thinner than their attached ones. When blood passes from the ventricle to the pulmonary artery the valves are placed against the sides of the vessel; when the current is checked a portion of it falls back towards the ventricle, and the valves are thrown inwards and completely close the tube. Behind the valves, at the commencement of the artery, are three dilations or pouches, bounded below by the valves themselves, and called the *sinuses of Valsalva*. From the inner surface of the ventricular walls project the fleshy columns, or *Carneæ Columnæ*, which form a network from which the chordæ tendinæ spring.

The *Left Auricle* is smaller than the right, but its walls are thicker. It is situated at the left postero-superior part of the heart and consists of a *sinus* and an *appendix*. On laying open the cavity we find the openings of the *pulmonary* veins, usually two pairs, one pair on the right and the other on the left of the sinus; they are not guarded by valves. On the floor is the *auriculo-ventricular* opening, communicating with the left ventricle.

The *Left Ventricle* is larger, rounder, and more prominent than the right, projecting lower and forming the apex. Its external wall is thicker than that of the right. On laying open the cavity two openings are seen, the left *auriculo-ventricular* opening and the *aortic*. The former is guarded by the *bicuspid* or *mitral* valves. The valves have the same general characters as the *tricuspid*. The aortic opening is deeply seated in the supero-anterior part of the ventricle, a little to the right of the auriculo-ventricular opening, from which it is separated by one of the segments of the mitral valve. It is guarded by three semi-lunar valves similar to those of the right side, but stronger. The rest of the inner surface has the same general characters as the right side.

The *Structure of the Heart* consists of a fibrous frame work, muscular and connective tissue, vessels and nerves, the whole being covered by one, and the cavities lined by another serous membrane.

The mass of the heart is composed of muscular fibres connected by areolar tissue. The fibres are involuntary, and of a deep red color, differing from other involuntary muscles (the œsophagus excepted), in being

transversely and longitudinally striated. They are smaller than voluntary fibres and are anastomatic.

The muscular fibres are attached to a frame work which consists of fibro cartilaginous rings surrounding the auriculo-ventricular and arterial openings. Between the aortic ring and the auriculo-ventricular openings is a fibro cartilaginous mass which in the ox is replaced by a bone, the os cordis.

The *Endocardium* is the name given to the serous membrane which lines the cavities of the heart. It is continuous with the lining membrane of the blood vessels.

The *Pericardium* is a fibro serous sac which encloses and is reflected over the heart and origins of the large blood vessels. It is composed of two layers, an external fibrous and an internal serous. The serous secretes a pale, lubricating fluid, the liquor pericardii.

Course of the Circulation. The venous blood is carried into the right auricle by the anterior and posterior vena-cavæ, passes through the right auriculo-ventricular opening into the right ventricle, thence through the pulmonary artery to the lungs. It returns through the pulmonary veins to the left auricle, passes through the left auriculo-ventricular opening to the left ventricle, which propels it through the aorta and its branches into the system generally, the veins returning it again to the heart. The circulation therefore is double. The pulmonary, or lesser, being performed by the right side; and the Somatic, or greater, by the left side of the heart.

The *Arteries* are tubes conveying the blood from the heart, a series belonging to each circulation. Both arteries leave the heart by a single trunk which subdivides and terminates in capillaries whence the veins originate. The large arteries are usually deep seated, occupying the cavities of the trunk and inner surfaces of the limbs, where they are less exposed to injury. When they pass over an articulation they are usually found on the flexor side. Arteries freely communicate with each other, forming what are called anastomoses. Arteries are dense and elastic, possessing great power of resistance. Their walls consist of three tunics, an external, middle and internal. The internal, or serous, is thinnest; the middle tunic is contractile, elastic,

dense, and of a yellow color, consisting of non striated muscular tissue and elastic fibre; the external coat is made up of areolar tissue and elastic fibres. The arterial sheaths consists of cellular tissue intimately connected with the surrounding textures. An artery is usually accompanied by a vein and nerve, all of which may lie in the same sheath, the vein being more superficial. The coats of arteries are supplied with nutrient blood vessels, the vasa vasorum, which come from neighboring vessels. The external coat is very tough, while the middle and internal ones are elastic and brittle; on ligaturing an artery the middle and internal coats give way, while the external remains intact.

The *Capillaries* are interposed between the termination of arteries and the commencement of veins, forming plexuses which vary much in arrangement. Their average diameter is about one three-thousandth of an inch, varying in different textures, smallest in the brain and mucous membrane of the intestines, largest in the skin, in glands, and the inter or of bones. All arteries do not terminate in capillaries, an exception being in the erectile tissue, where they end in cells or cavities placed at the origin of the veins.

The *Pulmonary Artery* springs from the right ventricle, curves upwards and backwards, and divides into right and left branches, which penetrate the substance of their respective lungs, along with the bronchii, ramifying in the lung along with the bronchial tubes and terminating in capillaries, which form a dense network on the walls of the air cells, the branches belonging to different lobules do not anastomose; from these capillaries spring the radicles of the pulmonary veins. The pulmonary is the only artery in the adult that conveys venous blood.

The *Common Aorta* is the main trunk of the arterial system. It arises from the left ventricle, passes upwards and forwards for about two inches, then divides into anterior and posterior aortæ. The former supplying the fore extremity, neck and head, and the latter the rest of the body and limbs.

Coronary Arteries.—In addition to its terminal branches, the aorta gives off right and left coronary or cardiac arteries, which nourish the tissues of the heart.

The *Posterior Aorta* is larger and longer than the anterior. It commences about the level of the 4th dorsal vertebra, passes upwards and backwards, forming the aortic arch, reaches the left side of the spine at the 6th or 7th dorsal vertebra. It passes straight backwards through the haitus aorticus to the abdomen, and terminates at the posterior part of the sublumbar region by dividing into external and internal iliacs. It is divided into thoracic and abdominal portions. It furnishes parietal and visceral branches.

Parietal Branches.

Aortic Intercostals	Phrenic
Lumbar	Middle Sacral

The *Intercostals* are doublets, 17 in number, the last 13 of which arise directly from the posterior aorta (the first arises from the superior cervical and the nex three from the dorsal artery.) The intercostals, after leaving the trunk skirt the dorsal vertebra, and divide into inferior or intercostals and superior or dorso-spinals. The former branch is the larger, and travels along the grooved posterior border of the rib down the side of the thorax, and supplies the pleura, intercostal and thoracic muscles. The dorso-spinal branch is distributed to the dorsal muscles and integument, and supplies the cord and its coverings.

The *Lumbar* arteries, 5 or 6 pairs, originate like the intercostal and divide into *superior*, or lumbo-spinal, which supply the muscles of the loins, and send branches to the cord, and *inferior* which supplies the abdominal muscles. The *Phrenic* supplies the diaphragm. The *middle sacral* is a mesian continuation of the posterior aorta, often absent in the horse.

Visceral Branches.

Broncho-Œsophageal—Thoracic.

Cœliac Axis, *Great Mesenteric,* *Small Meseuteric,* *Renal.* *Spermatic* *Small Testicular.*	Abdominal.

The *Bronchial* supply the lungs, the *œsophageal* the œsophagus.

The *Cæliac axis* arises from the lower surface of the aorta as it enters the abdomen; is about an inch long, and divides into Gastric, Splenic and Hepatic. The gastric is distributed to the stomach; the splenic to the spleen, and the hepatic to the liver, pancreas, and pyloric end of the stomach.

The *Great Mesenteric* arises a little behind the cœliac axis and splits into right, left and anterior divisions. It is distributed to the mesentry, from it twigs proceed to the small intestine and to a portion of the large.

The *Small Mesenteric* artery arises three or four inches behind the great mesenteric. It supplies the floating colon and rectum.

The *Renal* arteries are right and left, leave the aorta at right angles, and pass straight to the hilus of the kidney; an anterior branch supplies the suprarenal capsule.

The *Spermatic* arteries, right and left, become, in the female, the *utero-ovarian*. Their diameter considered, they are the longest arteries in the body, and they give off no lateral branches; pass through the inguinal canal down the anterior border of the spermatic cord.

The *Utero-Ovarian* arteries supply, in the female, the uterus and ovaries.

The *Small Testicular*, or artery of the cord, is small, passes throngh the inguinal canal, and supplies the tissues of the cord, first giving branches to the ureter, vas deferens and peritoneum.

The *Posterior Aorta*, at the level of the last lumbar vertebra, gives off the external Iliac arteries, and a little posterior to this the rest of the trunk bifurcates, forming the internal Iliac arteries, which are short, thick trunks. They supply the pelvic viscera, and partially the muscles of the hindquarters.

The *External Iliac* arteries arise below the last lumbar vertebra, curving obliquely outwards and downwards. At the level of the ileo-pectineal line it becomes the *femoral*. The external Iliac gives off the *circumflex ilii*. The *Femoral* is the artery of the thigh. It runs to the inferior part of the off femor,

becoming the *Popliteal*. In its course it gives off various branches which supply the muscles of the thigh. The Popliteal passes under the popliteal muscle, and at the upper part of the tibia bifurcates into *anterior* and *posterior Tibial*. The posterior tibial passes down the posterior part of the tibia to the hock, to which it gives branches, and then divides into *internal* and *external Plantar*, each of which clings to its own side of the deep flexor tendons, passing down to the fetlock. The *anterior tibial* passes down to the hock, where it becomes the *Metatarsal*, and passes down to the fetlock and joins the plantar arteries, from which proceed the arteries of the foot.

The *Anterior Aorta* is rather more than an inch in length and passes obliquely upwards and forwards; it divides into right and left arteria innominata, or brachial arteries.

The *Brachial* arteries separate at an acute angle, and pursue a diverging course towards the anterior aperture of the thorax, whence they proceed to the limbs, winding round the first ribs, the right one, being the largest, gives off the *common carotid*. The following arteries are given off alike by both brachial arteries:—the Dorsal, Superior Cervical, Vertebral, Internal Thoracic, External Thoracic, Inferior Cervical, Prescapular and Subscapular, each of which supplies the region its name indicates. When the brachial reaches the humerus it assumes the name of the *humeral* artery and descends along the inner side of the humerus to the elbow joint, just below which it becomes the *posterior radial* artery, having in the meantime given off the *anterior radial* and a number of small branches. It passes down the inner side of the forearm and divides at the distal end of the radius into large and small *metarcarpals*. It can be felt just behind the insertion of the flexor brachi. The *large metacarpal* is the true continuation of the posterior radial, and it descends along with the flexor tendons to just above the fetlock, where it divides into the *external* and *internal digital* arteries.

The *Common Carotid* artery is given off by the right brachial. On reaching the anterior opening of the thorax it divides into *right* and *left carotids* which pass up the neck, one on each side of the trachea, to a level

with the larynx, giving off several branches in their course. At the larynx each terminates in a trifurcation forming the following arteries: The Occipital, Internal Carotid and External Carotid. The *occipital* ascends and passes through the anterior foramen of the atlas, supplying the muscles of the poll, and sending a branch into the spinal canal, joins with its fellow of the opposite side, forming the *bassilar*, which passes along the base of the brain. The *internal carotid* passes through the foramen lacerum basis cranii and is distributed to the brain. The *external carotid* is the continuation of the carotid itself and it supplies the muscles of the mouth, face, ears and eyes.

Veins are vessels which return the blood to the heart, and they consist of two sets, the pulmonary, which convey arterial blood from the lungs to the left, and the systemic, which convey venous blood from the somatic capillaries to the right auricle. They are larger and more numerous than the arteries. The smallest commence at the capillaries, and converge to form larger ones, terminating in trunks which enter the heart. They are *superficial* and *deep*. The former lie immediately beneath the skin, and are mostly unaccompanied by arteries. The latter are situated deeply, and usually related with arteries, and hence are called *satellite veins*. Two veins sometimes accompany one central artery. Veins anastomose more freely than arteries. In the head they form dilated pouches or sinuses, and they form plexuses in the palate and foot. Their coats are thinner but stronger than those of arteries, and collapse when empty. They have three tunics arranged like those of arteries. The majority of veins are provided with *valves*, somewhat similar to the semi-lunar ones at the origins of the great arteries, being a fold of the lining membrane, and their use is to prevent a reflux of blood when the flow is interrupted. They are absent in the pulmonary, cranial, spinal, pedal and osseus veins and vena cavæ. Veins may originate from arteries without the intervention of capillaries, as in the erectile tissues of the penis.

The *Pulmonary veins* return the blood from the lungs to the left auricle. They converge to form four trunks, which enter the auricle by four openings. These are the only veins which convey arterial blood.

The *Posterior Vena Cava* corresponds to the posterior aorta. It commences at the entrance of the pelvic cavity; formed by the union of the common iliac veins, which are formed by the union of the internal and external iliac veins, which return the blood from posterior extremities and hinder part of trunk. It runs forward under the lumbar vertebræ; on reaching the superior border of the liver it inclines downwards, occupies the anterior fissure of the liver, passes through the foramen dextrum into the thoracic cavity, through a notch in the right lung, and enters the right auricle of the heart.

The *Portal vein* collects the blood from the visceral organs of digestion; it commences in the sublumbar regions by the union of three large branches, is directed forwards, passes through the pancreatic ring, reaches the liver, enters the gland at the posterior fissure, and is distributed like an artery, terminating in the hepatic veins, which. leaving the liver at the anterior fissure, enter the cava by minute oblique openings.

The *Anterior Vena Cava* returns the blood from the head, neck and fore extremities and part of the thorax. It is formed between the first pair of ribs by the union of the 2 jugular and 2 brachial veins, receiving the internal thoracic, vertebral, superior cervical, dorsal and the great vena azygos. The *brachial vein* receives the blood from the anterior extremity. The *jugular vein*, the great vein of the head and satellite of the carotid artery, commences by two branches, its origin corresponding to the breaking up of the external carotid artery. It passes down the neck, superficially placed, occupying the *jugular gutter*, a canal formed by the levator humeri and sterno-maxillaris muscles, it enters the thorax and joins its fellow.

The *Lymphatic* or *Absorbent* system is connected with the blood vascular system, and consists of a series of glands and tubes which absorb and convey to the blood certain fluids, a number of glandular bodies, through which the tubes frequently pass, and the fluids themselves, which are *lymph* and *chyle*. These are called lymphatic vessels because they convey a limpid fluid, clear and transparent; or absorbent vessels because they absorb alimentary matters. The absorb-

ents of the chyle are called *lacteals* or *chyliferous* vessels, but they do not differ in character, or anatomical structure, from the others. The lymphatics unite to form two large trunks, the *thoracic duct* and the *right lymphatic vein*, both of which enter the venous system near the heart. Delicate in structure, and transparent, they are present in nearly every tissue, and although more numerous than the blood vessels their capacity is probably not greater. The walls of the larger vessels consist of 3 coats. The coat of the smaller vessels, *lymph capillaries*, consists of membranous and cellular layers. The lymphatic vessels are beaded in appearance, due to valves in their interior which aid the onward flow of their contents; they may pass through two or more glands, or may enter the central trunk without approaching any gland. The *lymphatic glands* are small, round or oval in shape, varying in size from a hemp seed to a kidney bean, and are of a pale red color.

Lymph is a colorless fluid, containing a number of objects which resemble the white corpuscles of the blood. These are lymph corpuscles, and they are thought to be formed in the lymphatic glands.

Chyle is a milky fluid found in the lacteals or lymphatic vessels of the intestines during digestion. It contains corpuscles similar to those of the lymph. Since both the lacteal and posterior lymphatic vessels lead to the great lymphatic trunk or thoracic duct, it follows that the lymph and the chyle become mixed.

The *Thoracic duct* is the largest and longest lymphatic vessel. It receives all the others, except those of the right anterior extremity, and the right side of the head, neck and thorax. It originates in the lumbar region by a very irregular dilatation, called the *receptaculum chyli*, into which flow the contents of the neighboring vessels. From the anterior aspect of this reservoir the duct proceeds forward on the right side of the vertebræ, enters the thoracic cavity through the hiatus aorticus, passes along the vertebræ until it reaches about the sixth dorsal, where it curves downwards to the left side over the base of the heart, terminating in the jugular confluent about the anterior border of the first rib. The orifice is guarded by a valve which prevents the influx of blood. The

lymphatics which form the affluents of the thoracic duct may be divided into five groups, comprised within the following divisions of the body, viz.: Posterior region, Digestive viscera, Thoracic viscera, Thoracic walls, Anterior region.

The *Lymphatic vein* is the second principal trunk. It is situated near the junction of the jugular veins, and terminates in their confluent. It receives the vessels from the right anterior extremity, and the right side of the head, neck and thorax. Its opening into the confluent is also guarded by a valve.

The lymphatics of the posterior region are divided into the following groups: Sublumbar, Inguinal (deep and superficial), Popliteal, Iliac and Precural.

Digestive viscera is divided into the Lymphatics of rectum and floating colon, of large colon, of cæcum, of small intestines, of stomach, of spleen and of liver.

Thoracic viscera to the viscera of the thorax.

Thoracic walls into those of the walls and the diaphragm.

Anterior region into Prepectoral, Guttural, Submaxillary, Prescapular and Brachial.

Neurology.

The nervous system includes those organs which may be regarded as receiving and interpreting impression, and regulating the vital functions. It is divided into two minor systems. The *Cerebro spinal*, which is to a considerable extent influenced by the will of the animal, and the *Sympathetic* or *ganglionic* system, which comprises the nerves of organic life, and are not directly influenced by the will. Each of these has its own central and peripheral organs. In the first the centre is made up of two portions, one large and expanded, the *brain*, or encephalon, which occupies the cranial cavity; and the other, the *spinal cord*, is elongated and continuous with the brain, being lodged in the canal of the vertebral column. The communicating portion of this system consists of the cerebro spinal nerves, which leave the axis in symmetrical pairs, and are distributed to the voluntary muscles, and the organs of common sensation and special sense.

In the second system the central organ consists of a chain of ganglia connected by a nerve cord, which ex-

tends from the head to the coccyx, on each side of the spine. The nerves of this system are distributed to the involuntary muscles, mucous membranes, viscera and blood vessels. The two systems have free intercommunication, ganglia being placed at the junctions.

Nervous Tissue is composed of two substances, distinguishable by their color, viz., the *white* and the *grey* matter, and when examined by the microscope two distinct structures, *fibres* and *cells* are found. The *fibres* convey impressions to the centres, and transmit stimula from the centres to the various organs. Those which convey impressions are termed *sensory nerves*, and those which transmit stimuli to the muscles are called *motor nerves*, those to the coats of blood vessels *vasa motor*. The *cells* are found chiefly in the nerve centres and they germinate nervous force. This reflection of nervous impulse from one nerve to another is known as *reflex action*.

The centre of the cerebro-spinal system is the cerebro-spinal axis, consisting of the brain and spinal cord, which, with their coverings or meninges are continuous with one another.

Meninges of the Spinal Cord.

The *cerebro spinal axis* is invested by three distinct membranes, viz.: the *dura mater* externally, the *arachnoid* in the middle, and the *pia mater* internally. The *dura mater* is a strong inelastic membrane. It extends from the foramen magnum, to which it is attached, and is continuous with the dura mater of the brain, to the posterior extremity of the neural canal, where, as a slender cord, it blends with the periostum of the first bone of the coccyx. It is loosely attached to the inner surface of the canal by a layer of areolar tissue and bloodvessels.

The *Arachnoid*, so-called from its resemblance to a spider's web, is a delicate serous membrane, and like other serous membranes, is a closed sac. It loosely envelopes the pia mater, leaving between them an interval, the *sub-arachnoidean* space, which contains the limped cerebro spinal fluid.

The *Pia mater*, the inner envelope of the cord, is a thin vascular membrane, composed of areolar tissue containing blood vessels. It closely invests the whole

surface of the cord, sends processes into its longitudinal fissures, and forms a sheath for the spinal nerves.

The *spinal cord* is a large, white, irregularly cylindrical cord, which extends from the foramen magnum to the sacral portion of the neural canal, where it terminates in a slender filament. It is loosely suspended in the canal to allow motion. It varies in size; is dilated at its origin, where it joins the medulla oblongata, and also between the 5th cervical and 2nd dorsal vertebræ, where the large nerves which form the brachial plexus are given off, and again at, and posterior to the 3rd lumbar, where the lumbar and sacral nerves which constitute the lumbo-sacral plexus arise. The cord is divided into two lateral columns by *longitudinal fissures*, superior and inferior. Each side is again divided conventionally into three parts by *lateral fissures*, a superior corresponding with the sensory, and an inferior with the motor roots of the spinal nerves. A transverse section of the cord shows the white matter externally in the form of two *semi-cylinders*, and the grey matter in the centre of each.

The grey substance presents the appearance of two crescentric shaped masses united in the middle by the grey commissure. Each crescent presents two cornua or horns. In the middle of the grey commissure the central spinal canal runs the whole length of the cord, being continuous anteriorly with the 4th ventricle of the brain.

The proportionate size of the brain and spinal cord varies in different animals, according to the position which they occupy in the scale of intelligence. The higher that postition the larger and heavier proportionately is the brain, and the smaller and lighter the cord relatively. Thus in man the brain averages 50 oz and the spinal cord 1½ oz, a proportion of 1 to 33. In the horse the brain averages about 23 oz and the cord 10½ oz, a proportion of 1 to 2-19.

The *Encephalon*, or brain, is that part of the cerebro spinal axis situated within the cranium. In form it is a slightly flattened and elongated ovoid body, which may be considered as consisting of 4 parts, viz., the medulla oblongata, the pons Varolii, the cerebellum and the cerebrum. It has coverings like the cord.

The *Medulla oblongata* is the prolongation of the spinal cord, extending to the pons Varolii, from which it is separated by a narrow fissure. It is pyramidal in shape, the narrowest part being continuous with the cord.

The *Pons Varolii* is a transverse projection on the base of the brain between the medulla oblongata and the crura of the cerebrum.

The *Cerebellum*, or lesser brain, is lodged in the posterior part of the cranial cavity, immediately above the medulla oblongata.

The *Cerebrum*, or great brain, occupies the anterior portion of the cranium. It consists of lateral halves separated by the longitudinal fissure. Deep sulci map out the surface of the hemispheres into numerous convolutions, the number of which and the depth of the sulci indicate the range of intelligence possessed by the animal, as the grey matter, which is believed to be the seat of the intellectual faculties, is found on the surface of the convolutions, and on the sides and bottom of the sulci, so that the deeper and more numerous these are the greater is the amount of grey matter in the brain.

Functions of Different Divisions of the Brain.

The *Medulla* oblongata is the conductor of impressions. The majority of centres for the various organic functions are situated in it, as the Respiratory centre, Convulsive centre, Diatetic centre, centre for Deglutation, Vomiting centre, etc.

The *Pons Varolii* is intimately connected with the co-ordination of the movements.

The *Cerebellum* regulates and co-ordinates the muscular movements of the body.

The *Cerebrum* is the organ of intellectual action, emotion and volition.

Cranial Nerves.

The nerves which are transmitted through the foramina at the base of the cranium, are called *cranial nerves*. They leave in pairs regularly deposed, one on the right and one on the left side, and are named numerically, according to the order in which they leave the cavity, and by names derived from the parts

to which they are distributed, or the functions they perform. There are 12 pairs.

1st.—The *Olfactory*, or nerve of special sense of smell, is distributed to the mucous membrane of the posterior part of the nasal fossa.

2nd.—The *Optic*, or nerve of special sense of sight, enters the eye and expands into the retina.

3rd.—*Motors Oculorum*, a motor nerve, is distributed to most of the muscles of the eye.

4th.—*Pathetic*, a motor nerve, the smallest of the 12, is distributed to the superior oblique muscle of the eye.

5th.—*Trifacial*, a nerve of common sensation and motion and indirectly of special sense, is the largest cranial nerve, and belongs to the class of mixed nerves. It is divided into three branches, viz., the Ophthalmic, Superior Maxillary and Inferior Maxillary branches. The *Ophthalmic* subdivides into the frontal, lachrymal and nasal. The frontal is distributed to the skin of the forehead and the muscles above the eye. The lachrymal to the lachrymal gland, and muscles and skin of the anterior part of the ear. The nasal to the pituitary membrane on the walls of the nasal fossa; it gives a branch to the membrana nictitans and one to the lachrymal sac. The *Superior Maxillary* branch subdivides into the Orbital, Anterior Palatine, Posterior Palatine. Nasal and Dental branches, which supply the parts their names ind cate. The *Inferior Maxillary* branch is the largest of the three and subdivides into the Masseter, Buccal, Internal Pterygoidean, Lingual, Mylo hyoidean and Dental branches. The *lingual* is the nerve of the special sense of taste.

6th.—*Abducens*, a motor nerve, supplies the abductor oculi and the external portion of retractor oculi muscles.

7th.—*Facial*, a motor nerve, goes to the muscles of the face.

8th.—*Auditory*, the nerve of special sense of hearing, supplies the internal ear.

9th.—*Glasso Pharyngeal* is a mixed nerve distributed principally to the tongue and pharynx.

10th.—*Pneumogastric*, a mixed nerve, is remarkable for its extent, and for the numerous dissimilar organs it supplies It gives branches to the various respira-

tory organs and to the stomach and œsophagus. It also gives branches to the heart and lungs. It anastimoses freely with other cerebro spinal and with the sympathetic nerves.

11th.—*Spinal accessory*, a motor nerve, arises from the whole extent of the cervical portion of the spinal cord and receives fillaments from the brain. It is distributed chiefly to the muscles of the neck and shoulders.

12th.—*Hypo Glossal* is a motor nerve, and is distributed to the muscles of the tongue.

Spinal Nerves.

The nerves which eminate from the spinal cord and make their exit through the intervertebral foramina are collectively known as the *spinal* nerves. They consist of from 42 to 43 pairs and are divided according to the regions into 8 cervical, 17 dorsal, 6 lumbar, 5 sacral, and 6 or 7 coccygeal pairs. The whole of the spinal nerves originate by two orders of roots, *superior* or *sensory*, and *inferior* or *motor* roots. The former are larger and more numerous, arising from the superior lateral fissure, and the latter from the inferior lateral fissure of the cord. In the intervertebral foramina there is a ganglion on each of the superior roots underneath which the inferior root passes. The union of the two roots constitute the spinal nerve which, immediately on passing through the foramen divides into 2 branches, a superior distributed to the spinal muscles and skin which covers them, and an inferior, longer and larger, distributed to the inferior and lateral parts of the trunk, and in some cases to the extremities. The spinal nerve sends various communicating branches to the sympathetic system.

Sympathetic System.

The *Spmpathetic*, or ganglionic system of nerves, the nerves of organic life, consists of two large cords or chains of nerves, which extend from the head to the posterior extremity of the sacrum, under the lateral parts of the borders of the vertebræ on each side of the columns. These nerve cords are furnished with a number of ganglia, which both give and receive numerous communicating filaments from the cerebro spinal nerves. A sympathetic ganglion is a nerve centre

to which converge various so-called *afferent* branches, motor, sensory, and sympathetic, while the filaments which leave the ganglion to supply the various organs are known as emergent or *efferent* branches, which thus exercise a mixed and varied function. They supply the blood vessels, glands and viscera. The sympathetic system is divided into five regions, viz., the Cephalic, Cervical, Dorsal or thoracic, Lumbar or abdominal, and Sacral or pelvic,

Aesthesiology.

We will now consider the organs of special sense and common sensation.

The *Ear*. The apparatus of hearing is composed of 3 parts, viz., the external, middle and internal ear, the two first being accessory, for the collection and transmission of sound, and the latter the essential organ, which receives the impressions thus conveyed.

The *external ear* consists of the *concha*, or projecting shell-like orifice, and the *meatus auditorius externus*, or passage which extends from the concha to the tympanic membrane bounding the cavity. It is partly osseous and partly cartilaginous, and is narrower in the middle than at either extremity. Its lining is a continuation of the skin of the concha, and it gradually becomes thinner as it descends, and is perforated by a number of small openings from the *ceruminous glands* which secrete the wax of the ear. The cartilages of the external ear are the *conchal*, *annular* and the *scutiform*. The mobility of the organ in the solipedes is so great that it is regarded as the chief organ of expression.

The *middle ear*, or tympanum, is an irregular long cavity within the petrosal bone. It is bounded externally by the membrana tympani, or *drum* of the ear; internally by the bony walls of the internal ear, anteriorly by the Eustachian tubes, and posteriorly by the mastoid cells. A chain of bones, the auditory ossicles, stretch across the tympanum. They are the *malleus*, *incus*, *stapes* and *lenticular* bone or *os orbiculare*. The cavity is filled with air and communicates with the phárynx by the Eustachian tubes. The chain of bones transmits the impression received from the membrani tympanni to the internal ear, upon which the auditory nerve is distributed.

The *internal ear*, or labyrinth, is the ultimate part of the organ of hearing, and consists of the *vestibule*, *semi-circular* canals and *cochlea*. It consists of a series of cavities hollowed out of the petrous portion of the temporal bone communicating externally with the middle ear through the *fenestra ovalis* and *fenestra rotunda*, and internally with the cranial cavity through the *meatus auditorius internus*, which transmits the auditory nerve.

The Eye.

The apparatus of vision comprises the essential organ, the globe of the eye or eye-ball, and its accessory parts or appendages. The *globe* of the eye is spherical in form, having the segment of a smaller sphere engrafted on its anterior surface, and increasing its antero-posterior diameter. It consists of a membranous sac containing certain transparent humours of different densities, which serve as refracting media. It is attached to the orbit by the muscles which move it, and reposes on a cushion of fat which not only maintains it in its proper position, but also assists in steadying its movements.

The *Tunics* of the eye are three in number: 1st, the *Scleoric* and *Cornea*; 2nd, the *Choroid* and *Iris*; and 3rd, the *Retina*. The sclerotic coat and cornea form the external tunic. Four-fifths of the globe are invested by the sclerotic, the remaining one-fifth by the cornea.

The *sclerotic* coat is a dense white fibrous membrane, which extends from the insertion of the optic nerve to the cornea. Its external surface is in connection with the cellular and adipose tissue and with the muscles of the eye ball, the tendons of which expand over it and form a thin tendinous layer, the *tunica albuginea*, which is partly covered by the conjunctiva and forms the white of the eye. Its internal surface is attached to the *choroid* coat by cellular tissue. Its anterior opening is elliptical, and presents a bevelled edge, which receives the cornea in the manner which a watch glass is received by the groove in its case. Posteriorly it is pierced for the passage of the optic and ciliary nerves and the ciliary arteries.

The *Cornea* is composed of 2 layers, the *cornea propria* and the *cornea elastica*. It is transparent and

elliptical and fits into the groove in the sclerotic. Its anterior surface is convex, its posterior concave.

The *second tunic* of the eye-ball is formed by the choroid and iris. The *choroid* coat is a thin, vascular membrane of a brownish or black color. It is composed of three layers, external, middle and internal. The *external* consists principally of veins, "*vena vorticosa*," with pigment cells, to which its color is due. The *middle* layer is formed by the ciliary arteries, which form a fine capillary plexus called the *tunica Ruyschiana*. The *internal*, or pigmentary layer, is composed of hexagonal cells, containing black pigment granules. On the posterior wall the black pigment is absent, causing a peculiar bluish lustre, which, owing to its brilliancy, has received the name of the *tapetum lucidum*. The *ciliary muscle* is a white ring of fibres which forms the bond of union between the external and middle tunic of the eye. The ciliary processes, from 60 to 80 in number, are arranged in a circle, and are formed by the plating or folding inwards of the middle and inner layers of the cornea. Their circumference is attached to the ciliary muscle and their central border is received between corresponding folds of the suspensory ligament of the crystalline lens or zonula of Zinn.

The *Iris* is a thin diaphragm or curtain, suspended immediately in front of the crystalline lens, its periphery being connected with the choroid coat and ciliary muscle, and its centre being pierced by an elliptical opening, the *pupil*. It is variously colored, but in the horse is generally brown, with more or less of a yellow tinge, but sometimes it is almost white or grey, when the animal is said to be "wall-eyed." Its anterior surface is slightly convex, and its posterior surface covered with a deep purple ligament, called the *uvea*, from its resemblance in color to a ripe grape. Two sets of fibres enter into the formation of the iris, one of which, converging from the circumference to the centre, has the power of dilating the pupil; the other, surrounding the margin of the pupil on its posterior surface and blending with the radiating fibres, has the power of contracting it. The small bodies on the upper pupillary margin of the iris, three or four in number,

are the *corpora nigra*, their use appearing to be that of concentrating the rays of light, and preventing their too direct passage through the pupil.

The *third tunic* is the retina which is prolonged forwards to the ciliary processes. It is the terminal expansion of the optic nerve over the internal surface of the choroid coat from which it is easily separated. It consists of 9 layers, viz.: 1st, Internal limiting layer; 2nd, Optic nerve fibres; 3rd, Ganglionic cells; 4th, Internal molecular layer; 5th, Internal granular layer; 6th, External molecular layer; 7th, External granular layer; 8th, External lining membrane; 9th, Basilary layer, or rods and cones. The *Ciliary* zone, or Zonula of Zinn, is a thin vascular layer which connects the anterior margin of the retina with the anterior surface of the lens, and presents a number of folds which are received between corresponding folds of the ciliary processes.

Humours of the Eye.

These, the reflecting media, are 3 in number, viz.: the aqueous and vitreous humours, and the crystalline lens.

The *Aqueous* humour consists chiefly of water with an alkaline reaction, and completely fills the anterior and posterior chambers of the eye; both chambers are lined by a serous membrane which secretes the aqueous humour. The *anterior* chamber is the space between the internal surface of the cornea and the iris, pupil and ciliary muscle. The posterior chamber is the narrow space bounded in front by the iris, and behind by the capsule of the lens.

The *Vitreous* humour occupies about four-fifths of the whole interior of the globe. It is a highly albuminous and perfectly transparent substance of the consistance of jelly, enclosed in a delicate membrane, the *hyaloid*, from the inner surface of which numerous lamella are sent inwards to form the compartments in which the fluid portion is contained. If this fluid escapes, or be destroyed, it will not be reproduced.

The *Crystalline* humour, or lens, is situated immediately behind the pupil, in front of the vitreous humour, and is surrounded by the ciliary processes which slightly overlap its margin. It is bi convex, the convexity

of the posterior face being the greater, and is enveloped by a transparent elastic membrane, the *capsule* of the lens. It is constructed of concentric layers of laminæ, of which the external are soft and the internal firmer. It is supported in its place by the ciliary zone.

The motor muscles of the globe of the eye are seven, five of which are *straight*, the other two *oblique*. The *superior* oblique elevates and rotates the eye-ball. The *inferior* depresses and turns the eye inwards.

The *Appendages* of the eye are the eye-brows, eye-lids, membrana nicitans, conjunctiva, caruncula lachrymalis, lachrymal apparatus and ocular sheath.

The *eye-brows*, very rudimentary in the horse, are the eminences formed by the orbital processes of the frontal bones. They are furnished with a few long hairs and serve to interrupt too vivid rays of light and to exclude foreign bodies from the eye.

The *eye-lids* are two movable curtains, superior and inferior, which protect the eye. Entering into their structure are skin, muscles, fibrous tissue, tarsal cartilage, Meibomian glands and conjunctiva. The *tarsal cartilages* form the frame work of the free borders of the eye-lids, and are attached to the bones of the orbit by the fibrous tissue. The *Meibomian glands* are situated between the tarsal cartilages and conjunctiva, and they secrete a fluid which prevents the eye-lids adhering together during sleep.

The *Conjunctiva*, the mucous membrane of the eye, is very thin and very vascular. It lines the entire surface of the eye-lids, being continuous with the skin, covers the anterior part of the membrana nictitans and passes down the nasal duct. It is reflected over the whole anterior surface of the globe.

The *Membrana Nictitans*, or accessory eye-lid, is situated near the nasal angle between the globe and the side of the orbit. It is composed of elastic fibro cartilage and is irregular in form. Posteriorly it is continuous with the pad of fat which is insinuated between all the muscles of the eye. When the eye is in its natural position only the margin of the membrane can be seen, but when, by contraction of the straight muscles, the globe is drawn back, pressing on the pad of fat, the membrane is pressed more or less over the anterior surface of the eye. The movement, which is

instantaneous, is for the purpose of removing foreign bodies from the eye.

The *caruncula lachrymalis* is a small, round, reddish body, seen in the inner canthus. Its use is to direct the tears to the lachrymal canals.

The *Lachrymal Apparatus* consists of the lachrymal gland, lachrymal canals, lachrymal sac and nasal duct. The *gland* is situated in the superior part of the eye and secretes the tears destined to lubricate the anterior surface of the eye. The secretion is carried to the inner canthus where it enters the *lachrymal canals*, which carry it to the *sac*, a reservoir lodged in a fossa of the lachrymal bone, and is the origin of the *lachrymal or nasal duct*, which is a long membranous canal which commences at the sac, passes through a conduit of the bone, and terminates on the internal surface of the nasal opening. It is lined by a continuation of the conjunctiva.

The Skin and its Appendages.

The skin and its appendages constitute the external covering of the body. It consists of two parts, the *dermis*, cutis vera, or corium, which forms the deep layer, and the *epidermis* or cuticle superficially placed. Its appendages are glands, and the epithelial modifications, hair, horn and hoof.

The *epidermis*, cuticle or scarf skin, is an epithelial structure forming a protective covering for the dermis. It is insensitive and nonvascular, and consist of agglutinated cells which are formed on the surface of the true skin. It is divided into a firm and transparent superficial, and a deep soft layer. The latter is the *rete mucosum*, in whose cells the pigment exists which gives color to the skin.

The *Dermis*, or true skin, is vascular and highly sensitive, being the seat of touch. It is attached to the underlying parts by a layer of areolar tissue. It consists of fibro-areolar tissue and vessels of supply, and is divided into two layers, the *deep* or *true dermis* and the *upper* or *papillary*. The blood vessels form dense capillary plexuses in the dermis, terminating by loops in the papillæ. The nerves also terminate in loops.

The *Glands* of the skin are *sebaceous* and *sudoriferous*. The former, lodged in the dermis, are most abundant in parts exposed to friction. They are filled with sebaceous matter, resembling suet, which is discharged into the hair sacs,

The *Sudoriferous*, or sweat glands, are situated in the subcutaneous areolar tissue, surrounded by a quantity of fat. They are small round bodies, each of which consists of one or more small tubes coiled into a ball; the free end of the tube opens on the surface by a funnel shaped orifice, The skin of the horse is characterised by its great sensitiveness, which is still further promoted by grooming and artificial protection. Few animals, if any, perspire as freely as the horse. The large quantity of pigment found in the skin is supposed to serve as a protection against the heat of the sun. An epithelial excresence appears in the distal part of the forearm internally, and on the proximal portion of the metatarsus, also internally. These (ergots or chesnuts) according to Chauveau, represent the vestige of the thumb.

Hair is an appendage of the skin and in most mammals forms the external covering. It is a special modification of the epidermis, having in its bulk the same essential structure; a hair consists of a root, shaft and point, The *root* has a bulbous enlargement at its extremity, and is lodged in a recess or *hair follicle*; at the bottom of each follicle is a conical vascular papilla similar in every respect to those on the surface of the skin. This papilla fits into a corresponding depression in the root of the hair. The ducts of one or more sebaceous glands enter into the follicle. About the muzzle of the horse are a number of largely developed strong hairs, commonly known as the cat hairs, from their resemblance to the whiskers of the cat. These are media of touch, their bulbs receiving filaments of sensory nerves.

The Foot.

(In equine anatomy the foot implies the hoof, with the bones and soft structures it contains.)

The study of the foot is of great practical importance, owing to the many diseases and injuries to which it is subject. It resolves itself into the consideration of the

hoof, or horny case, and the parts contained within it.

By maceration the hoof is divisable into 3 parts, the wall, sole and frog.

The *wall* is that part which is visible when the foot rests on the ground, and is divided into the toe, quarters, heels, bars, internal and external surfaces, and superior and inferior borders. The *toe* forms the front of the hoof, and is the deepest and thickest part of the wall, which gradually declines in height as it passes backwards to form the *quarters*; these occupy the space between the toe and heel. The wall decreases in thickness from before backwards, more markedly so at the inner portion. At the posterior part of the foot the wall takes, on each side, a sudden bend, forming an acute angle. and is continued inwards to the centre of the foot, where the two parts unite with the sole. The angles of inflection are called the *heels*, the inflections themselves the *bars*, the latter forming stays to the quarters. The *external surface* of the wall is convex, smooth, and covered by a thin layer, the *periople*, which is continuous above with the coronary frog band. The *internal surface* of the wall presents throughout the whole extent, white, parallel, perpendicular plates of horn, which extend from the coronary border to the sole, and are continued over the inner surface of the bars. These *insensitive*, or *horny laminæ*, vary from 500 to 600 in number, and are separated from each other by deep fissures in which are inserted the *sensitive laminæ*. The *superior* or *coronary* border of the wall presents a groove in which is lodged the *coronary band*, or ligament. In this groove are numerous minute orifices in which are inserted the secretory villi of the coronary band. The *inferior border* is that part in contact with the ground and to which the sole is attached. The inner surface of the inferior border is united in a very intimate manner with the periphery of the sole. The external layer of the horn is known as the crust, and is secreted by the coronary band, the rest being secreted by the sensitive laminæ.

The *Sole* is a thick plate of horn which helps to form the inferior surface of the foot. It is comprised between the inner border of the inferior part of the wall and the bars. It presents two surfaces and two borders.

The *inferior* or *external* surface forms a vault which is more or less concave in different animals. The *superior* or *internal* surface is uneavenly convex, and is studded with a number of small orifices which run obliquely forward; into these are inserted the vascular papillæ of the sensitive sole. The *external border* or circumference of the sole is convex, abuts upon and is united throughout its whole extent to the internal part of the inferior border of the wall, the union between the two being very intimate through the intervention of horny matter. The *inner border* represents a deep cut or notch in the form of the letter V, and is related with the bars, except at the narrow part, where it is bounded by the frog. The two angles uniting the outer and inner circumferences correspond to the heels, and are received between the wall and the bars. This is the seat of corns or bruises.

The *frog* is the prominent, somewhat pyramidal mass of spongy horn lodged between the bars, and filling up the triangular space. It has four surfaces, a base and an apex. The *inferior* or *external* surface is irregular, and presents a longitudinal triangular cavity, which varies in width and depth, being broadest and deepest in well formed feet. This cavity is the *cleft* of the frog, bounding which are two sloping projections which unite at the apex of the frog anteriorly, and diverge posteriorly where they gain the heels. The *superior* or *internal* surface is also very irregular, but exactly the reverse of the inferior surface; where the one is hollow the other has projections and vice versa. It presents over its whole surface numerous small foramina, into which are inserted the vascular or secreting papillæ of the sensitive frog. The lateral surfaces incline obliquely from above downwards and from without inwards. In their upper third they are firmly united to the external surface of the bars and anteriorly to the notch in the sole. Between the bars and the frog are the *commissures* of the frog. The *base* or *posterior* extremities constitute the *heels*, or *bulbs* of the frog which are separated by the cleft. They cover the angles of inflection of the walls and are continued around the external part of the superior surface of the wall in the form of a band, which is the *coronary frog band*. It is from the inferior border of

this that the thin covering of the hoof is continued. The *summit*, or *toe*, of the frog is the anterior pointed portion which is inserted into the narrow part of the notch in the sole.

There are certain internal structures proper to the foot, viz., the lateral cartilages, sensitive frog, coronary ligament or band, sensitive laminæ, and sensitive sole.

The *lateral* cartilages are two thin plates of fibro cartilages of an irregularly quadrangular form, which surmount the wings of the coffin bone.

The *sensitive frog* occupies the posterior and central part of the foot, filling up the irregular space between the lateral cartilages, flexor tendon, and os pedis, superiorly and laterally, and the horny frog inferiorly. It is continuous with the sensitive bars and sole, and the coronary ligament. It is made up of an external layer of cuticular structure, the villi of which secrete the horny frog; below this is a layer of capillary blood vessels.

The *Coronary* substance, or *band*, or *ligament*, is that vascular structure which occupies the groove on the superior border of the wall. It consists of a dense fibrous band which is connected with the coffin bone and extensor tendon by the medium of dense cellular tissue; reposing on this is a plexus of blood vessels which is covered by a modification of true skin, containing numerous papillæ which enter the funnel-shaped openings in the crust, the horn of which is thus secreted. The coronary band presents along its upper border a narrow lip, or process, the *perioplic ring*, which secretes the horn of the peripole.

The *Sensitive Laminæ* are the continuation of the coronary band, and are attached to the coffin bone by a dense fibrous membrane, in which ramify the vascular plexus emanating from the bone. These highly organized plates are interposed between, and firmly attached to the horny laminæ on the wall, and are covered by minute papillæ which secrete the horny laminæ. On their inferior extremity are a few papillæ which help to secrete the horny sole.

The *Sensitive sole*, continuous with the sensitive laminæ and frog, is firmly attached to the coffin-bone. It secretes the horny sole.

Foetal Circulation.

In the *fœtus* there is a direct communication between the right and left auricle, by the *foramen ovale* in the interauricular septum. There is also a communicating branch between the pulmonary artery and the posterior aorta, the *ductus arteriosus*. There are two large arteries, the *umbilical*, which arise from the internal iliacs, pass along the side of the bladder and out of the umbilical opening along the umbilical cord to the placenta. The umbilical vein leaves the placenta, passes up the cord, enters the umbilicus, runs along the floor of the abdomen to the liver where it joins the portal vein.

(We will now trace the course of the fœtal circulation.)

The purified blood leaves the placenta by the umbilical vein, which is formed by the junction of numerous branches; on entering the abdomen it passes along the floor of the abdomen to the liver. It joins the portal vein, thus gaining the hepatic veins, thence it proceeds to the posterior vena-cavæ, where it mingles with the venous blood from the posterior regions. The mixed blood is conveyed by the posterior cava into the right auricle and passes directly through the foramen ovale into the left auricle, thence to the left ventricle to be forced into the aorta, the major part passes through the anterior aorta to the fore extremities and head; the remainder passes into the posterior aorta.

Venous blood is returned from the anterior extremity by the anterior vena-cavæ to the right auricle, passes directly to the right ventricle along with a small portion of the blood from the posterior vena-cava. The right ventricle propels it through the pulmonary artery, only a small portion passing into the impervious lungs to be returned to the left auricle by the pulmonary veins, the greater part going through the ductus arteriosus to the posterior aorta where it becomes mixed with a portion of blood from the left ventricle. In the posterior aorta it flows backwards to supply the posterior extremities and abdominal viscera. The chief portion, however, on arriving at the termination of the aorta enters the umbilical arteries and is returned to the placenta to be purified. At birth, when respiration

has been established, the placental circulation ceases, the foramen ovale rapidly closes up, the ductus arteriosus contracts, and together, with the umbilical arteries and veins, becomes obliterated.

It will be seen by the above that the fœtus is nourished by blood less perfectly purified than that of the adult, the blood becoming mixed in the liver, in the heart, and in the posterior aorta by means of the ductus arteriosus. It should also be borne in mind that the blood supplying the posterior region is less pure than that supplying the anterior. This accounts for the fact that at birth the anterior region is better developed than the posterior.